IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

PLAYTEX PRODUCTS, INC.,	)	
	)	
Plaintiff,	)	
	)	C.A. No.
v.	)	
	)	JURY TRIAL DEMANDED
FRUIT OF THE EARTH, INC.,	)	
	)	
Defendant.	)	

COMPLAINT

Plaintiff Playtex Products, Inc. ("Playtex") brings this action against Defendant Fruit of the Earth, Inc. ("FOTE"), alleging as follows:

The Parties

1. Playtex is a Delaware corporation having a principal place of business at 300 Nyala Farms Road, Westport, CT 06880.

2. Upon information and belief, FOTE is a Delaware corporation having a place of business at 2520 West Irving Boulevard, Irving, TX 75061.

Jurisdiction and Venue

3. This Court has subject matter jurisdiction over this action under 28 U.S.C. §§ 1331 and 1338, as this action arises under the patent laws of the United States, 35 U.S.C. § 1, *et seq*. and under the Lanham Act, 15 U.S.C. § 1051, *et seq*.

4. This Court has personal jurisdiction over FOTE because FOTE is a resident of Delaware, having incorporated in this state. In addition, upon information and belief, FOTE is doing business in the State of Delaware and has committed and/or induced others to commit acts of infringement in the State of Delaware, and thus has sufficient contacts with

Delaware such that compelling it to appear and defend in the forum does not offend traditional notions of fair play and substantial justice.

5. Venue is proper in this district pursuant to 28 U.S.C. §§ 1391(b) and 1400(b).

CLAIMS FOR RELIEF

COUNT I

(Patent Infringement, 35 U.S.C. § 271)

6. Playtex incorporates by reference, as if set forth in full herein, paragraphs 1 through 5 above.

7. Playtex is the assignee of United States Patent No. 7,014,842, titled "Sunscreen Composition," which issued March 21, 2006 ("the '842 patent"). Playtex owns all rights, title and interest in and to the '842 Patent. A true and correct copy of the '842 patent is attached hereto as Exhibit A.

8. Upon information and belief, and in violation of 35 U.S.C. § 271, FOTE has been and is now infringing the '842 Patent by manufacturing, using, selling, offering to sell and/or supplying sunscreens covered by one or more claims of the '842 Patent, including without limitation FOTE's Kids Sunscreen Continuous Spray Lotion.

9. FOTE's foregoing infringement has been willful and deliberate, rendering this case exceptional within the meaning of 35 U.S.C. § 285.

10. Plaintiff has been damaged and will be irreparably injured by FOTE's continuing infringement, for which Plaintiffs have no adequate remedy at law. FOTE's infringing activities will continue unless enjoined by this Court.

COUNT II

(Trade Dress Infringement, 15 U.S.C. § 1125)

11. Playtex incorporates by reference, as if set forth in full herein, paragraphs 1-10 above.

12. Prior to the launch of Banana Boat® Ultramist™ Kids Tear-Free™ Continuous Lotion Spray Sunblock, Playtex devoted significant time and expense to developing its bottle design so that it would be distinctive and memorable to consumers.

13. Playtex purposely designed the bottle of its Banana Boat® Ultramist™ Kids Tear-Free™ Continuous Lotion Spray Sunblock with a yellow, blue and white color scheme ("Banana Boat Trade Dress"). The background color is a bright yellow, chosen by Playtex to distinguish the KiDS line of Banana Boat® products from its other product lines, each of which contain a different, distinctive background color. Complementing the background color scheme is the word KiDS prominently displayed on the upper center of the product packaging. The SPF 50 value is set off in white lettering with a red background. The Banana Boat Trade Dress is depicted in Exhibit B.

14. The Banana Boat Trade Dress color scheme is repeated throughout its entire KiDS product line. The suntan lotion bottles all contain the same bright yellow background color and the word KiDS prominently displayed on the upper center of the product.

15. The color scheme, additional pictorial elements, labeling and design layout of the Banana Boat Trade Dress contribute to an overall appearance that is distinctive among suntan lotion products.

16. As a result of Playtex's extensive advertising, promotional efforts, and the distinctiveness of the Banana Boat Trade Dress, Playtex's Banana Boat Trade Dress has acquired invaluable goodwill, recognition and secondary meaning among consumers.

17. On information and belief, FOTE has recently introduced a confusingly similar suntan spray lotion to the market called Kids Sunscreen Continuous Spray Lotion. FOTE sells its Kids Sunscreen Continuous Spray Lotion to at least one major chain store. A photograph of the FOTE Kids Sunscreen Continuous Spray Lotion bottle is attached hereto as Exhibit C.

18. FOTE's Kids Sunscreen Continuous Spray Lotion bottle uses yellow, blue and white colors and denotes the SPF 50 value in a manner that is confusingly similar to the well-known Banana Boat Trade Dress. Additionally, FOTE's Kids Sunscreen Continuous Spray Lotion bottle uses essentially the same size, shape and overall design as the Banana Boat Trade Dress, even down to a distinctive semi-transparent blue top. FOTE's Kids Sunscreen Continuous Spray Lotion bottle includes, *inter alia*, combinations of the following Banana Boat Trade Dress elements:

a. Bright yellow-colored background;

b. Blue and white lettering;

c. Prominent display of the word "KIDS;"

d. SPF 50 in white lettering with a red background;

e. Phrase: "Very Water Resistant;"

f. Phrase: "Tear Free;"

g. Phrase: "No tearing – Alcohol Free;"

h. Identical bottle width;

i. Identical bottle shape;

j. Nearly identical bottle height;

k. Nearly identical semi-transparent blue cap; and

l. Similar overall design layout.

19. Although isolated elements appearing on Playtex's Banana Boat Trade Dress also appear on other suntan lotion products, FOTE has placed a number of elements on its Kids Sunscreen Continuous Spray Lotion bottle such that the product has the same look and feel of the Banana Boat Trade Dress.

20. FOTE's product mimics a number of elements of the Banana Boat Trade Dress. Given the remarkable similarity in their appearance, it is likely that consumers will confuse FOTE's Kids Sunscreen Continuous Spray Lotion product with Playtex's product.

21. FOTE's infringement of Playtex's Banana Boat Trade Dress is likely to cause consumer confusion, which will be exacerbated by the fact that FOTE's Kids Sunscreen Continuous Spray Lotion product and Playtex's product are sold in the same market, and in at least one major chain store are displayed directly next to each other.

22. Plaintiff has been damaged and will be irreparably injured by FOTE's continuing infringement of Playtex's Banana Boat Trade Dress, for which Plaintiffs have no adequate remedy at law. FOTE's infringing activities will continue unless enjoined by this Court.

Requested Relief

WHEREFORE, Playtex prays that this Court enter judgment:

a. finding that FOTE has infringed and/or induced others to infringe the '842 patent under 35 U.S.C. § 271;

b. finding that FOTE's infringement is willful and deliberate;

c. preliminarily and permanently enjoining FOTE and its subsidiaries, agents, officers and employees, and all others acting in concert with them, from infringing and inducing infringement of the '842 patent;

d. ordering FOTE to pay Playtex an amount that adequately compensates Playtex for FOTE's infringement of the '842 patent, no less than a reasonable royalty;

e. ordering FOTE to pay court costs, pre-judgment interest, post-judgment interest and attorney's fees under 35 U.S.C. §§ 284 and 285;

f. increasing damages found or assessed due to FOTE's willful infringement of the '842 patent;

g. finding that FOTE has infringed Playtex's Banana Boat Trade Dress under 15 U.S.C. § 1125;

h. preliminarily and permanently enjoining FOTE and its subsidiaries, agents, officers and employees, and all others acting in concert with them, from infringing Playtex's Banana Boat Trade Dress and manufacturing, distributing, marketing or selling any product that is confusingly similar in appearance to Playtex's Banana Boat products;

i. directing FOTE to recall from distribution and destroy all bottles, and sales material relating to FOTE infringing products;

j. ordering FOTE to pay Playtex an amount that adequately compensates Playtex for FOTE's infringement of the Banana Boat Trade Dress;

k. awarding increasing damages pursuant to 15 U.S.C. § 1117 for FOTE's willful infringement of the Banana Boat Trade Dress; and

l. granting Playtex such other and further relief as is just and proper.

Demand for Jury Trial

Playtex hereby demands a jury trial on all claims and issues triable of right by a jury.

MORRIS, NICHOLS, ARSHT & TUNNELL LLP

Maryellen Noreika (#3208)
1201 North Market Street
P.O. Box 1347
Wilmington, DE 19899
(302) 658-9200
mnoreika@mnat.com

Attorneys for Plaintiff Playtex Products, Inc.

April 16, 2008

EXHIBIT A

(12) **United States Patent**
Dueva-Koganov et al.

(10) **Patent No.: US 7,014,842 B2**
(45) **Date of Patent: Mar. 21, 2006**

(54) **SUNSCREEN COMPOSITION**

(75) Inventors: **Olga V. Dueva-Koganov**, White Plains, NY (US); **James P. SaNogueira**, Suffern, NY (US)

(73) Assignee: **Playtex Products, Inc.**, Westport, CT (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 78 days.

(21) Appl. No.: **10/856,737**

(22) Filed: **May 28, 2004**

(65) **Prior Publication Data**

US 2005/0013781 A1 Jan. 20, 2005

Related U.S. Application Data

(60) Provisional application No. 60/474,362, filed on May 29, 2003.

(51) **Int. Cl.**
A61K 7/42 (2006.01)
A61K 7/44 (2006.01)
A61K 7/00 (2006.01)

(52) **U.S. Cl.** **424/59**; 424/60; 424/400; 424/401

(58) **Field of Classification Search** 424/59, 424/60, 400, 401
See application file for complete search history.

(56) **References Cited**

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International Search Report corresponding to PCT International Application No. PCT/USO4/17037 Apr. 1, 2005.

Primary Examiner—Shelley A. Dodson
(74) *Attorney, Agent, or Firm*—Ohlandt, Greeley, Ruggiero & Perle, L.L.P.

(57) **ABSTRACT**

There is provided a composition comprising one or more photoactive compounds and one or more optimization agents. Surprisingly, the composition requires a small amount of optimization agent to efficiently optimize the polarity, critical wavelength, SPF, PFA, Star Rating, photostability, or any combinations thereof, of the composition. Subsequently, an efficient sunscreen composition is achieved.

94 Claims, 7 Drawing Sheets

FIGURE 1

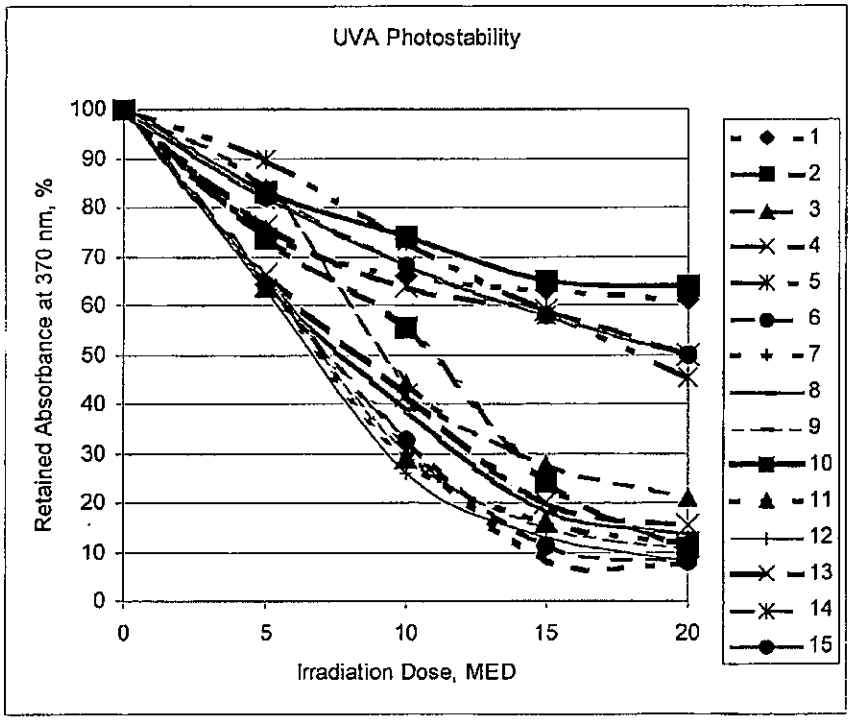

UVA Photostability
Retained Absorbance at 370 nm, %
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
Irradiation Dose, MED
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

FIGURE 2

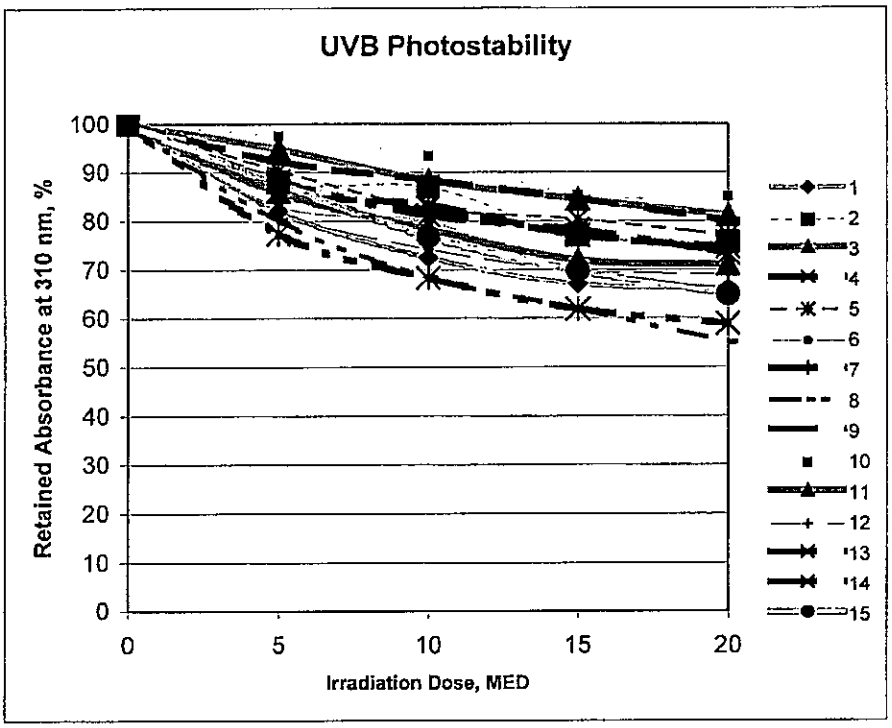

UVB Photostability
Retained Absorbance at 310 nm, %
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
Irradiation Dose, MED
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

FIGURE 3

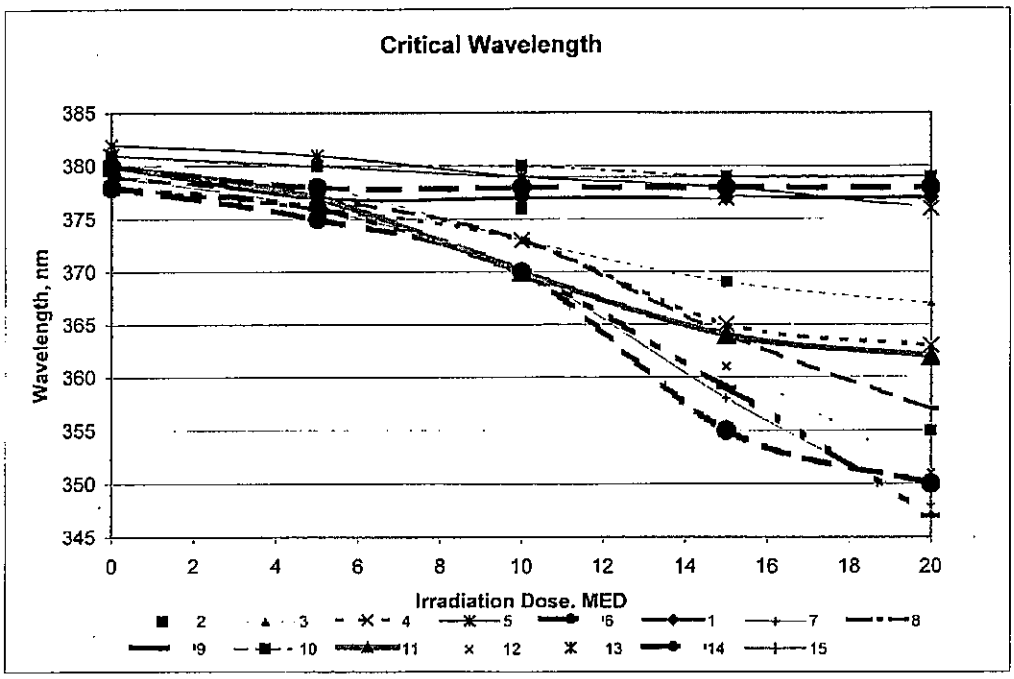

Critical Wavelength
Wavelength, nm
385
380
375
370
365
360
355
350
345
0
2
4
6
8
10
12
14
16
18
20
Irradiation Dose, MED
2
3
4
5
6
1
7
8
9
10
11
12
13
14
15

FIGURE 4

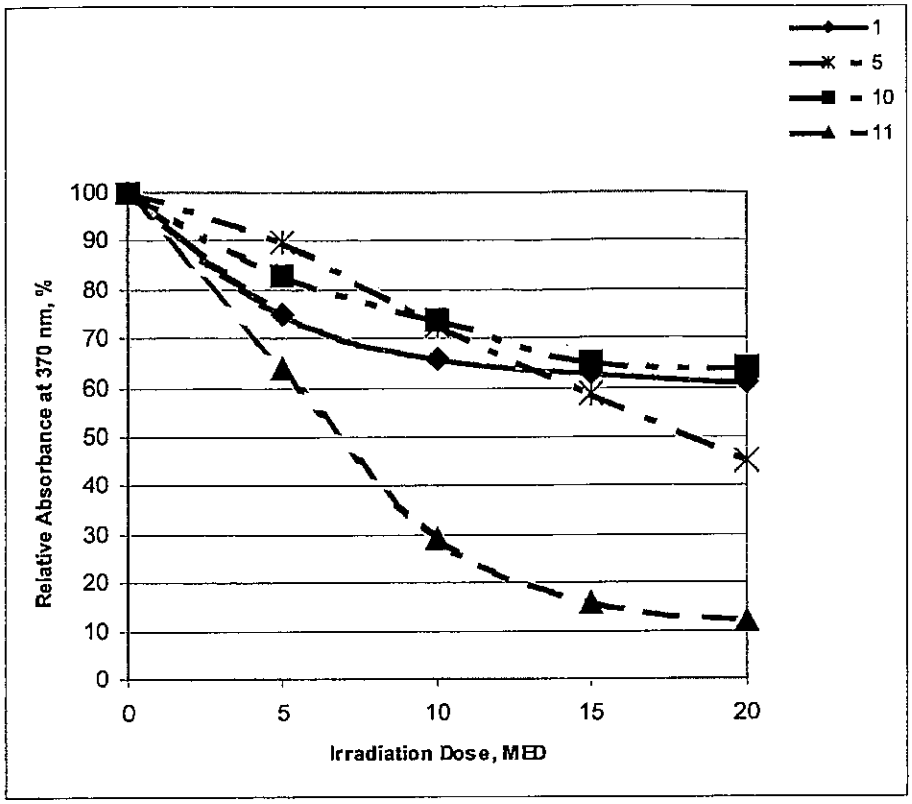

1
5
10
11
100
90
80
70
60
50
40
30
20
10
0
Relative Absorbance at 370 nm, %
0
5
10
15
20
Irradiation Dose, MED

FIGURE 5

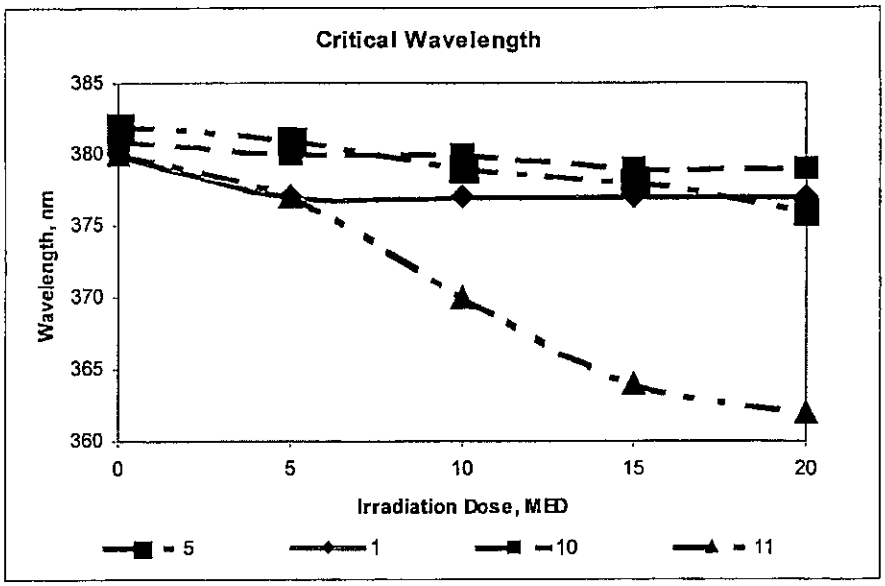

Critical Wavelength
385
380
375
370
365
360
Wavelength, nm
0
5
10
15
20
Irradiation Dose, MED
5
1
10
11

FIGURE 6

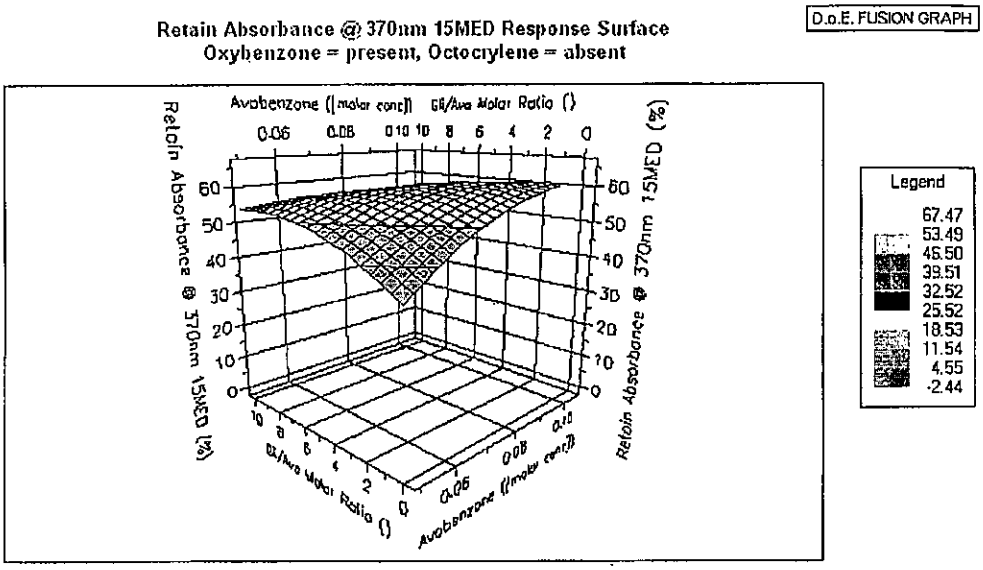
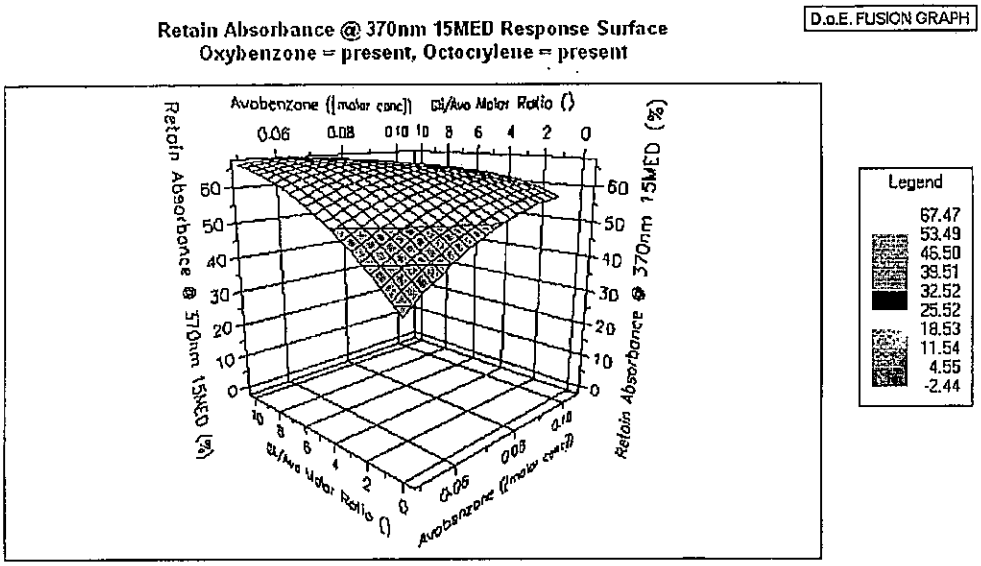

Retain Absorbance @ 370nm 15MED Response Surface
Oxybenzone = present, Octocrylene = absent
D.o.E. FUSION GRAPH
Avobenzone ([molar conc]) 0.06 0.08 0.10
Oil/Ave Molar Ratio () 10 8 6 4 2 0
Retain Absorbance @ 370nm 15MED (%)
Legend
67.47
53.49
46.50
39.51
32.52
25.52
18.53
11.54
4.55
-2.44

FIGURE 7


Retain Absorbance @ 370nm 15MED Response Surface
Oxybenzone = present, Octocrylene = present
D.o.E. FUSION GRAPH
Avobenzone ([molar conc])
Oct/Avo Molar Ratio ()
Retain Absorbance @ 370nm 15MED (%)
Legend
67.47
53.49
46.50
39.51
32.52
25.52
18.53
11.54
4.55
-2.44

SUNSCREEN COMPOSITION

RELATED APPLICATION

This application claims priority to pending U.S. Provisional Patent Application Ser. No. 60/474,362 filed on May 29, 2003, which is incorporated in its entirety by reference herein.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to a photoprotective composition. More particularly, the present invention relates to a sunscreen composition having optimized polarity, critical wavelength, SPF PFA, photostability, Star Rating, or any combinations thereof. The present invention also relates generally to a method of optimizing photoprotective compositions.

2. Description of the Prior Art

Sunscreen compositions are applied to the skin to protect the skin from the sun's ultraviolet rays that can lead to erythema, a reddening of the skin also known as sunburn. Sunlight or ultraviolet radiation in the UV-B range has a wavelength of 290 nm to 320 nm and is known to be the primary cause of sunburn. Ultraviolet rays at a wavelength of 320 nm to 400 nm, known as UV-A radiation, produces tanning of the skin. However, in the process of doing so, the UV-A rays can damage or harm the skin.

Besides the immediate malady of sunburn, excessive sunlight exposure can lead to skin disorders. For instance, prolonged and constant exposure to the sun may lead to actinic keratoses and carcinomas. Another long-term effect is premature aging of the skin. This condition is characterized by skin that is wrinkled, cracked and has lost its elasticity.

As stated above, sunscreens are typically formulated with the goal of inhibiting skin damage from the sun's rays. The sunscreen composition filters or blocks the harmful UV-A and UV-B rays that can damage and harm the skin. It is believed that sunscreen agents accomplish this by absorbing the UV-A and/or UV-B rays.

Typically, the above-described UV-B filters are combined with the above-described UV-A filters in a solution with other lipophilic or oily ingredients and solvents to form an oil phase. The solvents are used to dissolve the sunscreen actives into the oil phase. Typically, but not necessarily, the oil phase is dispersed with the help of emulsifiers and stabilizers into an aqueous solution composed primarily of water, to make an emulsion, which becomes the final sunscreen composition.

One problem associated with the use of UV filters, and especially those that are rapidly-degrading photoactive compounds, is that they are not photostable and will degrade rapidly and exponentially when exposed to UV radiation. The organic UV-A filters most commonly used in commercial sunscreen compositions are the dibenzoylmethane derivatives, particularly 4-(1,1-dimethylethyl)-4'-methoxydibenzoylmethane (also called avobenzone, sold under the brand name PARSOL 1789). Other dibenzoylmethane derivatives described as UV-A filters are disclosed in U.S. Pat. Nos. 4,489,057; 4,387,089 and 4,562,067, the disclosures of which are hereby incorporated herein by reference. It is also well known that the above described UV-A filters, particularly the dibenzoylmethane derivatives, can suffer in rapid photochemical degradation, when used alone or when combined with the above-described most commercially used

UV-B filters. Thus, the efficiency of the sunscreen composition (i.e., SPF, PFA, critical wavelength, Star Rating) containing these photoactive compounds is compromised, unless the photodegradation is controlled by improving the photostability of the system in UVA and/or UVB regions.

By controlling the polarity of the solvent used in a sunscreen composition, the rate of photodecay of the photoactive compounds in the composition can be controlled. By controlling the polarity, greater stability is imparted to the photoactive compounds, thus resulting in a more stable overall composition. The dielectric constant, for example, is a good indicator or measure of polarity in a composition. This is due to the fact that the dielectric constant is a measure of both inherent and inducible dipole moments.

In addition, polar solvents tend to decrease the energy required to excite a pi-bonding electron, and increase the energy required to excite a non-bonding electron. This phenomenon is called "state switching" and is a mechanism by which photoactive compounds absorb UV radiation. By enhancing the state switching in a photoprotective or sunscreen composition, a more efficient UV absorbing composition can result.

It is also known that the use of different solvents in sunscreen formulations may increase or decrease the effectiveness of a sunscreen chemical. The shifts (hypsochromic to the lower wavelength or bathochromic to higher wavelength) in the UV spectrum are due to the relative degrees of solvation by the solvent of the ground state and the excited state of the chemical.

It has been found in the prior art that as the polarity of a solvent system including a dissolved, rapidly-photodegradable compound is increased, the rate of photodecay initially decreases, but then increases again as the polarity is further increased. Thus, a photodegradable compound in solution will degrade as a second-order function of the overall polarity of the solution. Currently accepted photochemical theory provides the possibility that the mechanism by which a photodegradable compound is stabilized is the transfer of a photonically-excited electron to a nearby molecule of the same or different species (see, e.g., N. J. Turro, Modem Molecular Photochemistry, Chapter 9, Benjamin/Cummings Publ. Co., Menlo Park, Calif. (1991)), incorporated by reference herein. Additional photochemical theory is believed to coincide with the electron transfer theory of Professor Rudolph A. Marcus of the California Institute of Technology, for which he received the 1992 Nobel Prize in Chemistry, incorporated by reference herein.

U.S. Pat. Nos. 6,485,713 and 6,537,529 to Bonda et al., consistent with the above-described theory, discloses the use of amides, malates and bis-urethanes in a solvent system to control the polarity of the solvent system in a sunscreen composition. The use of these specific components results in an oil phase having a dielectric constant no greater than about 12. The named components are used in an oil-in-water sunscreen composition in an amount about 0.1% to about 40% by weight of the total weight of the composition, and more preferably about 3 wt. % to about 20 wt. %.

In addition to the above, U.S. Patent Application Publication No. 2004/0057916 A1 to Bonda et al. discloses polymers and compounds including a diphenylmethylene or a 9H-fluorene moiety for use in sunscreen compositions to photostabilize UVA sunscreen actives.

Critical wavelength is another important aspect in optimizing the performance of a photoprotective composition. In 1994, Diffey described the Critical Wavelength in vitro method, which is based on the absorption spectrum of a sunscreen product obtained via UV substrate spectropho-

tometry (Diffey B L (1994) A Method for Broad-Spectrum Classification of Sunscreens. Intl J Cosmet Sci, 16: 47–52), which is incorporated by reference herein. The absorption spectrum of a sunscreen is characterized by an index, namely critical wavelength, which is the wavelength where the integral of the spectral absorbance curve reached 90% of the integral from 290 nm to 400 nm. The critical wavelength method is used to determine the breadth of UV protection and is the recommended method for the evaluation of long wave efficacy of sunscreen products. Therefore, by optimizing the critical wavelength properties of a photoprotective composition, enhanced photoprotection may result.

Another measure of a sunscreen composition's efficiency is the Star Rating (UVA/UVB Ratio) according to the Boots Star Rating System (4-star that was recently revised to 5 star category). The Star Rating is calculated as an indicator of the UVA absorbance properties of a sunscreen product, relative to UVB as described in the Revised Guidelines to the practical measurement of UVA:UVB ratios according to Boots Star Rating System. The calculation of the UVA:UVB absorbance ratio will typically yield values from zero (equal to no UVA absorbance) up to 1.0 (UVA absorbance equal to UVB).

What is absent in the prior art is a photoprotective composition having one or more agents that differ from the prior art that are capable of optimizing at least one of the following properties: polarity, critical wavelength, SPF, PFA, Star Rating, or any combinations thereof, in the oil phase, water phase, both phases, or the final sunscreen formulation; thus resulting in a more efficient and photostable photoprotective composition.

The present invention addresses this shortcoming by providing an efficient photoprotective composition having one or more optimization agents capable of optimizing at least one of the following properties: polarity, critical wavelength, SPF, PFA, Star Rating, photostability or any combinations thereof, in the oil phase, water phase, both phases of the composition, or the final sunscreen formulation.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an efficient photoprotective composition.

It is another object of the present invention to provide such a composition that is a sunscreen composition.

It is still another object of the present invention to provide such a composition having one or more optimization agents capable of optimizing the polarity, critical wavelength, SPF, PFA, Star Rating, photostability, or any combinations thereof of the oil phase, water phase, both oil and water phases, of the composition.

It is another object of the present invention to provide such a composition where the one or more optimization agents are lipophilic, hydrophilic, or both.

It is still another object of the present invention to provide such a composition where the one or more optimization agents have a dielectric constant greater than about 10.5.

It is still another object of the present invention to provide such a composition where the one or more optimization agents have a dielectric constant greater than about 13.

It is a further object of the present invention to provide such a composition where the one or more optimization agents are one or more alcohols, such as, for example, glycols, diols, or any derivatives thereof.

These and other objects of the present invention are achieved by a composition comprising one or more photoactive compounds and one or more optimization agents. Surprisingly, the composition requires a small amount of optimization agent to efficiently optimize the polarity, critical wavelength, SPF, PFA, Star Rating, photostability, or any combinations thereof, of the composition. Subsequently, an efficient sunscreen composition is achieved.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 is a graph depicting the UVA photostability of compositions according to the present invention and comparative examples;

FIG. 2 is a graph depicting the UVB photostability of compositions according to the present invention and comparative examples;

FIG. 3 is a graph depicting the critical wavelength of compositions according to the present invention and comparative examples;

FIG. 4 is a graph depicting the UVA photostability of compositions with a synergistic combination of optimizing agent and octocrylene according to the present invention;

FIG. 5 is a graph depicting the critical wavelength of compositions with a synergistic combination of optimizing agent and octocrylene according to the present invention;

FIG. 6 is a fusion graph depicting the photostability of avobenzone in a photoprotective composition according to the present invention; and

FIG. 7 is another fusion graph depicting the photostability of avobenzone in a photoprotective composition according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention provides photoprotective compositions that are uniquely formulated with one or more optimization agents that results in the optimization of one or more of the following properties: polarity, critical wavelength, SPF, PFA, Star Rating (UVA/UVB Ratio), photostability, or any combinations thereof, of the composition. Photoprotective compositions according to the present invention include, but are not limited to, sunscreens, cosmetics, paints, coatings, and the like.

A photoactive compound, as used herein, is a compound that responds to UV radiation photoelectrically. Examples of photoactive compounds include, but are not limited to, UV filters, pigments, or dyes.

By way of example, the present invention is illustrated herein by reference to a sunscreen composition for use on mammalian hair and/or skin. It is to be understood, however, that the principles set forth below apply equally to any photoprotective composition.

According to the present invention, a sunscreen composition is provided having one or more photoactive agents and one or more optimization agents. The resulting sunscreen composition is photostable and possesses optimized polarity, critical wavelength, SPF, PFA, Star Rating, photostability, or any combinations thereof, which results in a more efficient UV radiation-absorbing composition.

The one or more photoactive agents suitable for use in the sunscreen composition of the present invention include one or more UV filters. Suitable UV filters may include, but are not limited to, one or more compounds selected from the following categories (with specific examples): p-aminobenzoic acid, its salts and its derivatives (ethyl, isobutyl, glyceryl esters; p-dimethylaminobenzoic acid); anthranilates (o-aminobenzoates; methyl, menthyl, phenyl, benzyl, phenylethyl, linalyl, terpinyl, and cyclohexenyl esters); salicy-

lates (octyl, amyl, phenyl, benzyl, menthyl (homosalate), glyceryl, and dipropyleneglycol esters); cinnamic acid derivatives (menthyl and benzyl esters, alpha-phenyl cinnamonitrile; butyl cinnamoyl pyruvate); dihydroxycinnamic acid derivatives (umbelliferone, methylumbelliferone, methylaceto-umbelliferone); camphor derivatives (3-benzylidene, 4-methylbenzylidene, polyacrylamidomethyl benzylidene, benzalkonium methosulfate, benzylidene camphor sulfonic acid, and terephthalylidene dicamphor sulfonic acid); trihydroxycinnamic acid derivatives (esculetin, methylesculetin, daphnetin, and the glucosides, esculin and daphnin); hydrocarbons (diphenylbutadiene, stilbene); dibenzalacetone and benzalacetophenone; naptholsulfonates (sodium salts of 2-naphthol-3,6-disulfonic and of 2-naphthol-6,8-disulfonic acids); dihydroxy-naphthoic acid and its salts; o- and p-hydroxydiphenyldisulfonates; coumarin derivatives (7-hydroxy, 7-methyl, 3-phenyl); diazoles (2-acetyl-3-bromoindazole, phenyl benzoxazole, methyl naphthoxazole, various aryl benzothiazoles); quinine salts (bisulfate, sulfate, chloride, oleate, and tannate); quinoline derivatives (8-hydroxyquinoline salts, 2-phenylquinoline); hydroxy- or methoxy-substituted benzophenones; uric and vilouric acids; tannic acid and its derivatives; hydroquinone; benzophenones (oxybenzone, sulisobenzone, dioxybenzone, benzoresorcinol, 2,2',4,4'-tetrahydroxybenzophenone, 2,2'-dihydroxy-4,4'-dimethoxybenzophenone, octabenzone), dibenzoylmethane derivatives, avobenzone, 4-isopropyldibenzoylmethane, butylmethoxydibenzoylmethane, 4-isopropyl-dibenzoylmethane, octocrylene, drometrizole trisiloxane, and metal oxides (titanium dioxide, zinc oxide).

In one embodiment of the invention a photoactive compound is selected from the group consisting of UV-A filters, UV-B filters, or any combinations thereof. In a cosmetically-acceptable sunscreen embodiment for use on human skin, a photoactive compound preferably is selected from approved (if regulated), cosmetically-acceptable UV-A filters, UV-B filters, or any combinations thereof.

For example, for a product marketed in the United States, preferred cosmetically-acceptable photoactive compounds and concentrations (by way of example, reported as a percentage by weight of the total cosmetic sunscreen composition) include: aminobenzoic acid (also called para-aminobenzoic acid and PABA; 15% or less), avobenzone (also called butyl methoxy dibenzoylmethane; 3% or less), cinoxate (also called 2-ethoxyethyl p-methoxycinnamate; 3% or less), dioxybenzone (also called benzophenone-8; 3% or less), homosalate (15% or less), menthyl anthranilate (also called menthyl 2-aminobenzoate; 5% or less), octocrylene (also called 2-ethylhexyl-2-cyano-3,3 diphenylacrylate; 10% or less), octyl methoxycinnamate (7.5% or less), octyl salicylate (also called 2-ethylhexyl salicylate; 5% or less), oxybenzone (also called benzophenone-3; 6% or less), padimate O (also called octyl dimethyl PABA; 8% or less), phenylbenzimidazole sulfonic acid (water soluble; 4% or less), sulisobenzone (also called benzophenone-4; 10% or less), titanium dioxide (25% or less), trolamine salicylate (also called triethanolamine salicylate; 12% or less), and zinc oxide (25% or less).

Other preferred cosmetically-acceptable photoactive compounds and concentrations (by way of example, percent by weight of the total cosmetic sunscreen composition) include diethanolamine methoxycinnamate (10% or less), ethyl-[bis(hydroxypropyl)]aminobenzoate (5% or less), glyceryl aminobenzoate (3% or less), 4-isopropyl dibenzoylmethane (5% or less), 4-methylbenzylidene camphor (6% or less), terephthalylidene dicamphor sulfonic acid (10% or less), and sulisobenzone (also called benzophenone-4, 10% or less).

For a product marketed in the European Union, preferred cosmetically-acceptable photoactive compounds and concentrations (by way of example, reported as a percentage by weight of the total cosmetic sunscreen composition) include: PABA (5% or less), camphor benzalkonium methosulfate (6% or less), homosalate (10% or less), benzophenone-3 (10% or less), phenylbenzimidazole sulfonic acid (8% or less, expressed as acid), terephthalidene dicamphor sulfonic acid (10% or less, expressed as acid), butyl methoxydibenzoylmethane (5% or less), benzylidene camphor sulfonic acid (6% or less, expressed as acid), octocrylene (10% or less, expressed as acid), polyacrylamidomethyl benzylidene camphor (6% or less), ethylhexyl methoxycinnamate (10% or less), PEG-25 PABA (10% or less), isoamyl p-methoxycinnamate (10% or less), ethylhexyl triazone (5% or less), drometrizole trielloxane (15% or less), diethylhexyl butamido triazone (10% or less), 4-methylbenzylidene camphor (4% or less), 3-benzylidene camphor (2% or less), ethylhexyl salicylate (5% or less), ethylhexyl dimethyl PABA (8% or less), benzophenone-4 (5%, expressed as acid), methylene bis-benztriazolyl tetramethylbutylphenol (10% or less), disodium phenyl dibenzimidazole tetrasulfonate (10% or less, expressed as acid), bis-ethylhexyloxyphenol methoxyphenol triazine (10% or less), methylene bisbenzotriazolyl tetramethylbutylphenol (10% or less, also called TINOSORB M), and bisethylhexyloxyphenol methoxyphenyl triazine.(10% or less, also called TINOSORB S), Mexoryl XL (also called drometrizole trisiloxane, 15% or less), Mexoryl SX (15% or less).

The one or more photoactive compounds are present in the composition in an amount about 1% to about 40% by weight of the total weight of the sunscreen composition. The amount of sunscreen agent in the composition can vary in the above range depending on the sun protection factor (SPF) desired. Usually, the higher the SPF, the greater the total amount of sunscreen agent used in the composition. However, as demonstrated herein, the present invention provides the possibility of formulating a photoprotective composition with an increased or boosted SPF without the inclusion of additional sunscreen agent or increasing the total amount of sunscreen agent in the composition.

Preferably, the one or more sunscreen agents are included at about 2 wt. % to about 35 wt. % to achieve a SPF of about 2 to about 50. More preferably, the one or more sunscreen agents are included in an amount about 4 wt. % to about 30 wt. % to achieve a SPF value of about 4 to about 45.

The composition of the present invention must include one or more optimization agents. It has been unexpectedly found that the inclusion of one or more optimization agents according to the present invention in a sunscreen composition results in a stable, efficient composition.

The one or more optimization agents may be present in a photoprotective composition according to the present invention from about 0.1 wt. % to about 40 wt. %, based on the total weight of the composition. Preferably, the one or more optimization agents are present from about 0.5 wt. % to about 15 wt. %, and more preferably from about 1 wt. % to about 11 wt. %, based on the total weight of the composition.

Surprisingly, it has been found that only small amounts of the one or more optimization agents, on the order of about 0.1 wt. % to about 10 wt. %, based on the total weight of the composition, are required to effect the desired optimization of polarity, critical wavelength, SPF, PFA, Star Rating (UVA/UVB Ratio), photostability, or any combinations

thereof, in the composition. Preferably, the one or more optimization agents, taken alone or in combination, have a dielectric constant greater than about 10.5. More preferably, the one or more optimization agents, taken alone or in combination, have a dielectric constant greater than about 13.

Suitable optimization agents for use in the present invention may include, but are not limited to, diols, alcohols, glycols, polyhydric alcohols, polyhydric alcohol derivatives having one or more hydroxyl groups, or any combinations thereof. Preferably, the one or more optimization agents are one or more alcohols. More preferably, the one or more optimization agents are one or more diols, glycols, or any combinations thereof. Most preferably, diols are 1,2-diols.

Suitable glycols for use in the invention include, but are not limited to, pentylene glycol (1,2-pentanediol), neopentyl glycol (neopentanediol), caprylyl glycol (1,2-octanediol), etoxydiglycol, butylene glycol monopropionate, diethylene glycol monobutyl ether, PEG-7 methyl ether, octacosanyl glycol, arachidyl glycol, benzyl glycol, cetyl glycol (1,2-hexanediol), C_{14-18} glycol, C_{15-18} glycol, lauryl glycol (1,2-dodecanediol), butoxydiglycol, 1,10-decanediol, ethyl hexanediol, or any combinations thereof. It is believed that glycols, such as those listed above, have a dielectric constant greater than about 10.5.

Determining the polarity of a mixture or an emulsion can be performed in various ways. For example, determining a polarity can include measuring a property that is a function of polarity, such as a dielectric constant. Measurement of a dielectric constant of a liquid can be performed by various sensors, such as immersion probes, flow-through probes, and cup-type probes, attached to various meters, such as those available from the Brookhaven Instruments Corporation of Holtsville, N.Y. (e.g., model BI-870) and the Scientifica Company of Princeton, N.J. (e.g. models 850 and 870). For consistency of comparison, preferably all measurements for a particular filter system are performed at substantially the same sample temperature, e.g., by use of a water bath. Generally, the measured dielectric constant of a substance will increase at lower temperatures and decrease at higher temperatures.

Dielectric Constants of the following glycols and their derivatives have been measured (see Table 1).

TABLE 1

Dielectric Constants

Glycols/derivatives	Trade Name/ Manufacturer	Dielectric Constant, 23° C.
Pentylene Glycol	Hydrolite-5/Symrize	18.2
Diethylene Glycol Monobutyl Ether	™ DB Solvent/ Eastman	10.59
1,2-Hexanediol and 1,2-Octanediol (50:50 mixture)	Symdiol 68/Symrize	13.07
Ethoxydiglycol	Educol-421/MMP	13.69
Butylene Glycol Monopropionate	BG Monopropionate/ MMP	11.72
1,2-Octanediol (Caprylyl Glycol)	LexGard O/Inolex	10.61 (measured at 30° C.)*
1,2-Hexanediol		15.1
Polyethylene Glycol-7 Methyl Ether	Sasol	13.1

*Solid at room temperature (23 C.).

It has been surprisingly found that the inclusion of one or more optimization agents in a composition according to the present invention results in a SPF boost on the order of at least 25% as compared to a composition without one or more optimization agents. Particularly, a SPF boost on the order of at least about 30% is experienced by a composition according to the present invention.

In order to evaluate the unexpected SPF boost in photoprotective compositions by the one or more optimization agents according to the present invention, by way of example, the performance of 1,2-octanediol (caprylyl glycol) and pentylene glycol in vivo was evaluated. The following formulations outlined in Table 2 were tested in SPF studies (static and Very Water Resistant (VWR)). The SPF was determined using the method outlined in the Food and Drug Administration (FDA) Final Monograph for sunscreen testing published in the Federal Register, Vol. 64, No. 98, May 21, 1999, which is incorporated by reference herein.

Referring to Table 2 below, the differences among the formulations are the presence or absence of 1,2-octanediol (caprylyl glycol) and/or octocrylene.

TABLE 2

Sunscreen Compositions

Chemical/INCI/USP Name	Trade Name	MF2822-1 % w/w	MF2822-2 % w/w	MF2770-114 % w/w
Octinoxate	Neo Heliopan AV	7.50	7.50	7.50
Octyl Salicylate	Neo Heliopan OS	5.00	5.00	5.00
Homosalate	Escalol 567	5.00	5.00	5.00
Avobenzone	Parsol 1789	3.00	3.00	3.00
Octocrylene		NONE	NONE	2.50
Purified Water		60.03	65.03	62.53
Neopentyl Glycol Diheptanoate	Lexfeel 7	5.00	5.00	5.00
1,2-Octanediol	LexGard O	5.00	NONE	NONE
Tapioca Starch	Stabilex T	2.50	2.50	2.50
Acrylates/C12–22 Alkylmethacrylate Copolymer	Allianz OPT	2.50	2.50	2.50
Glycerin	Emery 917	2.00	2.00	2.00
Phenoxyethanol (and) Methylparaben (and) Butylparaben (and) Ethylparaben (and) Propylparaben (and) Isopropylparaben	Phenonip	1.00	1.00	1.00
Triethanolamine	TEA 99%	0.53	0.53	0.53
PEG-20 Almond Glycerides	Crovol A-40	0.35	0.35	0.35
Acrylates/C10–30 AlkylAcrylate Crosspolymer	Pemulen TR-2	0.27	0.27	0.27
Carbomer	Ultrez 10	0.15	0.15	0.15
Tocopheryl Acetate (USP)	Tocopheryl Acetate	0.05	0.05	0.05

TABLE 2-continued

Sunscreen Compositions

Chemical/INCI/USP Name	Trade Name	MF2822-1 % w/w	MF2822-2 % w/w	MF2770-114 % w/w
Disodium EDTA	Dissolvine Na2S	0.07	0.07	0.07
Aloe Barbadensis Leaf Extract	Aloe Oil Extract 101	0.05	0.05	0.05
		100.00	100.00	100.00

The results of the SPF tests are outlined below in Tables 3 through 5.

TABLE 3

Results for MF2822-1

	SPF Static	SPF VWR
Average SPF (N = 5)	37.06	35.00
Standard Deviation	2.20	0.00
Standard Error	0.98	0.00
t (one-tail)	2.132	2.132
A	2.10	0.00
SPF Label	34.96	35.00

TABLE 4

Results for MF2822-2

	SPF Static	SPF VWR
Average SPF (N = 5)	28.38	28.38
Standard Deviation	1.65	1.65
Standard Error	0.74	0.74
t (one-tail)	2.132	2.132
A	1.57	1.57
SPF Label	26.81	26.81

TABLE 5

Results for MF2770-114

	SPF Static	SPF VWR
Average SPF (N = 21)	37.02	36.25
Standard Deviation	2.98	2.29
Standard Error	0.65	0.50
t (one-tail)	1.725	1.725
A	1.12	0.86
SPF Label	35.00	35.00

The results of SPF tests demonstrate that the addition of 5 wt. % of 1,2-octanediol (caprylyl glycol) to the sunscreen formulation provided an SPF boost of more than 8 SPF units (about 30.5%) when compared to the formulation without 1,2-octanediol (caprylyl glycol). Sunscreen formulation with 5 wt. % of 1,2-octanediol (caprylyl glycol) and without octocrylene has a SPF VWR of 35.0, which is the same as the formulation with 2.5 wt. % of octocrylene and without 1,2-octanediol. Overall, the inclusion of one or more optimization agents according to the present invention, such as, for example, 1,2-octanediol (caprylyl glycol), in a sunscreen formulation results in a significant SPF boost. In addition, the inclusion of one or more optimization agents in a sunscreen formulation can result in a composition having a desired SPF with less amount of sunscreen active in the composition.

EXAMPLE 2

The following additional example demonstrates the effectiveness of the present invention in providing a stable and efficient photoprotective composition. A comparison of a composition according to the present invention (Comp. B) having a optimizing agent (in this case pentylene glycol) to one not having an optimization agent (Comp. A) is set forth below. The test methodology used to determine SPF is the same as that described above with respect to Example 1.

TABLE 6

Sunscreen Compositions With and Without Pentylene Glycol

	Weight %	
INCI Adopted Name	Comp. A	Comp. B
Water	62.3773	60.8773
Octyl Methoxycinnamate	7.5000	7.5000
Ethylhexyl Salicylate	5.0000	5.0000
C12–15 Alkyl Benzoate	5.0000	5.0000
Benzophenone-3	4.1000	4.1000
Isopropyl Myristate	4.0000	4.0000
Cocoglycerides	3.5000	3.5000
Glycerin	2.0000	2.0000
Acrylates/C12–22 Alkylmethylacrylate Copolymer	2.0000	2.0000
Butyl methoxydibenzoylmethane	1.5000	1.5000
Pentylene Glycol	NONE	1.5000
Phenoxyethanol (and) Methylparaben (and) Butylparaben (and) Ethylparaben (and) Propylparaben (and) Isobutylparaben	1.0000	1.0000
Triethanolamine	0.6500	0.6500
PEG-20 Almond Glycerides	0.3500	0.3500
Acrylates C10–30 Alkyl Acrylate Crosspolymer	0.3000	0.3000
Fragrance	0.2000	0.2000
Carbomer	0.1500	0.1500
Xanthan Gum	0.1000	0.1000
Disodium EDTA	0.0700	0.0700
Tocopheryl Acetate	0.0500	0.0500
Aloe Barbadensis Leaf Extract	0.0500	0.0500
Carthamus Tinctorius (Safflower) Seed Oil (and) Chamomile *Recutita* (*Matricaria*) Extract	0.0500	0.0500
Carthamus Tinctorius (Safflower) Seed Oil (and) *Lavandula Angustifolia* (Lavender) Extract	0.0500	0.0500
Yellow 5	0.0020	0.0020
Green 5	0.0007	0.0007
TOTAL:	100.0000	100.0000
Average SPF Static in vivo	<25.68	31.76
Average SPF VWR in vivo	<24.12	31.22

As is evident from this example, the inclusion of optimization agent according to the present invention, such as 1.5 wt. % pentylene glycol (1,2-pentanediol) in the sunscreen

formulation (Comp. B), results in an increase in SPF by more that 6 units (about 29%) due to the increased polarity of the oil phase.

While, as noted above, it has been unexpectedly found that one or more optimization agents according to the present invention boost SPF, it has also been unexpectedly found that the one or more optimization agents also photostabilize UVA sunscreens, such as avobenzone and its derivatives, and UVB sunscreens. As a result, both UVA and UVB protection is optimized. This is demonstrated by way of Example 3 below.

EXAMPLE 3

Test compositions were prepared with octocrylene (Positive control), glycols, glycol derivatives, or isopropyl myristate (Negative control) added to the following sunscreen components: AVOBENZONE—3 g; HOMOSALATE—15 g; OCTYL SALICYLATE—5 g, thus imitating the oil phase of a sunscreen formulation (see Table 7):

TABLE 7

	Compositions		
#	ADDITIVE:	g	DEC, 23 C.
Positive Control 1	Octocrylene	5	7.89
2	Pentylene Glycol	5	10.5
3	Ethoxydiglycol (Diethylene glycol monoethyl ether)	5	8.59
4	BG Monopropionate	5	8
5	1,2-Octanediol (Caprylyl Glycol)	5	8.1
Negative Control 6	Isopropyl Myristate	5	6.15
7	1,2-Hexanediol + 1,2-Octanediol	5	7.8
8	Diethylene Glycol Monobutyl Ether	5	7.6
9	1,2-Hexanediol	5	8
10	Octocrylene + 1,2-Octanediol	2.5 + 2.5	7.8
Negative Control 11	No additives	0	7.03
12	PEG-7 Methyl Ether	5	7.69
13	Octocrylene	2.5	7.79
14	Octocrylene and PEG-7 Methyl Ether	2.5 + 2.5	8.36
15	Octocrylene + 1,2-Octanediol + PEG-7 Methyl Ether	2.5 + 1.25 + 1.25	8.39

Referring to Table 7 above, the compositions were applied on Vitro-Skin (0.6 mg/cm2) and irradiated. The irradiation dose was 5 MEDs repeated 4 times (=20 MEDs total). Retained Absorbance at 370 nm (UVA photostability, FIG. 1), 310 nm (UVB photostability, FIG. 2) and critical wavelength (Table 8, FIG. 3) were determined for each composition before and after each irradiation dose in order to determine their photostability.

For each sunscreen composition, the filter system was blended with the solvent system to form an oil phase. Next, the dielectric constant of the oil phase was measured. Dielectric constant measurements were performed with a Scientifica Model 850 dielectric constant meter.

The resulting sunscreen oil phases were tested for photostability by measuring absorbance on a Labsphere UV-1000S Ultraviolet Transmittance Analyzer before and after irradiation with a Solar Light Company model 16S solar simulator (equipped with a WG 320 filter to transmit radiation greater than 290 nm) in 5 MED (105 mJ/cm.sup.2) increments up to 20 MED cumulative dose. Output was monitored by a PMA 2105 UV-B DCS Detector (biologically weighted) and controlled by a PMA 2100 Automatic Dose Controller (Solar Light Co.).

A synthetic skin substrate was used for testing the sunscreen compositions (VITRO-SKIN substrate by IMS, Inc. of Milford, Conn.). To prepare the substrate, a 300 g solution of 44 g of glycerin and 256 g of deionized water was added to an IMS hydrating chamber, and a sheet of VITRO-SKIN was placed in the hydrating chamber for approx. 16 hours. Several 6.5 cm squares were cut from the hydrated VITRO-SKIN and used for absorbance measurements.

To prepare slides for testing, sunscreen composition is drawn or placed into a pipette. The test composition is uniformly applied to VITRO-SKIN square (0.6 mg/cm^2). This application dose of the oil phase, 0.6 mg/cm^2, corresponds to the application dose of 2 mg/cm^2 of sunscreen formulation (typically the concentration of the oil phase in the sunscreen formulation is about 30%). The VITRO-SKIN square was then placed on a foam block, and the test material was spread by finger (covered with a latex glove or finger cot), first in a circular motion, then by a side-to-side motion during which the VITRO-SKIN is deformed by the pressure. The square was then mounted in a slide holder and allowed to dry for about 15 to 20 minutes.

To test photostability, a slide was positioned on the UV transmittance analyzer using registration marks, and a scan of 1 sq. cm spot on the slide was performed. The slide was then transferred to a holder placed adjacent to the solar simulator and, using a calipers, was positioned such that the beam of UV radiation exiting the solar simulator illuminated the same 1 cm spot on the slide. The following software settings were used: UV-B—290–320 nm; UV-A—320–400 nm; SPF—290–400 nm; Spectral Irradiance; Noon, July 3, Albuquerque, N.Mex.; SPF Spectral Irradiance and Erythermal Effectiveness settings as set by manufacturer. Following an exposure of 5 MED, the slide was again placed in position on the UV transmittance analyzer, and a scan of the exposed spot was performed. The procedure was repeated on the same 1 cm spot on the slide until the desired total radiation dosage was achieved.

TABLE 8

	Critical Wavelength						
Critical Wavelength, CW			MED				
ADDITIVE:	Amount, g	#	0	5	10	15	20
Octocrylene (Positive Control)	5	1	380	377	377	377	377
Pentylene Glycol	5	2	381	378	376	369	355
Etoxydiglycol	5	3	379	378	373	369	367
BG Monopropionate	5	4	378	376	373	365	363

TABLE 8-continued

Critical Wavelength, CW			Critical Wavelength MED				
ADDITIVE:	Amount, g	#	0	5	10	15	20
1,2-Octanediol	5	5	382	381	379	378	376
Isopropyl Myristate (Negative Control)	5	6	378	375	370	355	350
1,2-Hexanediol + 1,2-Octanediol	5	7	379	376	370	358	348
Diethylene Glycol Monobutyl Ether	5	8	379	377	373	364	357
1,2-Hexanediol	5	9	378	375	367	356	349
Octocrylene + 1,2-Octanediol	2.5 + 2.5	10	381	380	380	379	379
No additives (Negative Control)	0	11	380	377	370	364	362
PEG-7 Methyl Ether	5	12	380	377	370	361	351
Octocrylene (Positive Control)	2.5	13	381	378	378	377	376
octocrylene and PEG-7 Methyl Ether	2.5 + 2.5	14	380	378	378	378	378
Octocrylene + 1,2-Octanediol + PEG-7 Methyl Ether	2.5 + 1.25 + 1.25	15	381	380	379	379	379

As is evident by the results outlined in the graphs of FIGS. 1 and 2, as well as Table 8 and the graph of FIG. 3, it was unexpectedly found that the polarity of an oil phase alone is not just a single factor that affects the photostability of UVA sunscreens, such as avobenzone and its derivatives. Glycol or glycol derivative structure may also play a very important role in photostability. For example, sunscreen compositions containing 1,2-octanediol, BG monopropionate and 1,2-hexanediol have very similar dielectric constants (8.0–8.1). However, only 1,2-octanediol most effectively stabilizes avobenzone. It stabilizes avobenzone by increasing the retained absorbance at 370 nm, 310 nm, and minimizing the decrease of Critical Wavelength (CW) after UV irradiation.

It was also found unexpectedly that certain glycols, for example, pentylene glycol, ethoxydiglycol, BG monopropionate and 1,2-hexanediol can improve the photostability of UVB sunscreens at 310 nm without the significant improvement of the photostability of avobenzone at 370 nm and also critical wavelength.

Mechanisms of photostabilizing UVA and UVB sunscreens by diols, glycols and their derivatives may include, but are not limited to, external stabilization by hydrogen bonding. In addition, the one or more optimization agents, such as, for example, caprylyl glycol and pentylene glycol (most preferred optimizing agents) do not have σ-π bonds and unsaturated groups in their molecular structures. In addition, most preferred optimizing agents (caprylyl glycol and pentylene glycol) are 1,2-diols.

EXAMPLE 4

Referring to Table 2 above, the PFA of MF2822-1 and MF2822-2 compositions was measured by JCIA Method (methods described in co-pending patent application Ser. No. 10/779,314, filed Feb. 13, 2004, which is incorporated in its entirety by reference herein). PFA value is an indicator of a sunscreen's protection in UVA region, which is associated with photoaging, as opposed to the UVB region, which is associated with sunburn. PFA is also is related to the degree of photostabilization of UVA sunscreens, such as avobenzone and its derivatives. So a PFA boost to a sunscreen composition will directly correlate with higher UVA efficacy of a sunscreen as well as a higher degree of photostabilization of a UVA sunscreen.

It has been unexpectedly found that the inclusion of one or more optimization agents in a photoprotective composition according to the present invention results in a PFA boost to the composition, as compared to a composition without one or more optimization agents. A PFA boost on the order on at least 10% is experienced by the compositions according to the present invention. Particularly, a PFA boost on the order of greater than about 50% is experienced, and more particularly a PFA boost of greater than about 85% is experienced by a composition according to the present invention, as compared to a composition without one or more optimization agents.

PFA values for MF2822-1 and MF 2822-2 are outlined in Table 9 below.

TABLE 9

Average PFA Values	
MF2822-1	MF2822-2
10.34	5.51

The results of PFA tests have shown that the addition of 5 wt. % of 1,2-octanediol to the sunscreen formulation provided a PFA (PPD, JCIA) boost by almost 5 PFA units (about 88%) when compared to the formulation without 1,2-octanediol.

In addition to the above-described unexpected features of the present invention, it has also unexpectedly been found that there exists a synergistic effect on the photostability of UVA sunscreen, such as avobenzone and its derivatives, when octocrylene and one or more optimization agents, such as 1,2-octanediol (caprylyl glycol) are both present in a sunscreen composition. As a result of this synergistic effect, a photoprotective composition according to the present invention possesses at least a 10% increase in UVA photostability, at least a 10% increase in UVB photostability and a decrease in critical wavelength, as compared to a composition without the synergistic combination according to the present invention.

The one or more optimization agents to octocrylene may be present in a photoprotective composition in a weight ratio of about 0.01 to about 100. Preferably, the synergistic combination is present in a ratio between about 0.1 to about 10, and more preferably about 0.5 to about 5.

EXAMPLE 5

Referring to Table 10 below, octocrylene and/or 1,2-octanediol were added to the following sunscreen components: AVOBENZONE—3 g; HOMOSALATE—15 g; OCTYL SALICYLATE—5 g; which are intended to

resemble an oil phase of a sunscreen composition. It is noted that the base composition #'s 1, 5, 10 and 11 are described in Table 2 above.

TABLE 10

Compositions

ADDITIVE:	g	Table 2 Comp.
Octocrylene (Positive Control)	5	1
1,2-Octanediol	5	5
Octocrylene + 1,2-Octanediol	2.5 + 2.5	10
No additives (Negative Control)	0	11

The above compositions were applied on Vitro-Skin (0.6 mg/cm2) and irradiated. The irradiation dose was 5 MEDs repeated 4 times (=20 MEDs total). Retained Absorbance at 370 nm (Table 11 and FIG. 4), 310 nm (Table 12) and critical wavelength (Table 13 and FIG. 5) were determined for each composition before and after each irradiation dose in order to determine their photostability. The methodology is described above in more detail in Example 3.

TABLE 11

UVA Photostability

UVA Photostability 370 nm			MED				
ADDITIVE:	Amount, g	#	0	5	10	15	20
Octocrylene (Positive Control)	5	1	100	75	66	63	61
1,2-Octanediol	5	5	100	89.9	72.9	58.9	45.1
Octocrylene + 1,2-Octanediol	2.5 + 2.5	10	100	83	74	65	64
No additives (Negative Control)	0	11	100	64	29	16	12

TABLE 12

UVB Photostability

UVB Photostability, 310 nm			MED				
ADDITIVE:	Amount, g	#	0	5	10	15	20
Octocrylene (Positive Control)	5	1	100	82	72.5	67	66
1,2-Octanediol	5	5	100	90.4	82.8	80.4	77.1
Octocrylene + 1,2-Octanediol	2.5 + 2.5	10	100	97.4	93.4	85.3	85
No additives (Negative Control)	0	11	100	86	78.3	72	71

TABLE 13

Critical Wavelength

Critical Wavelength, CW			MED				
ADDITIVE:	Amount, g	#	0	5	10	15	20
Octocrylene (Positive Control)	5	1	380	377	377	377	377
1,2-Octanediol	5	5	382	381	379	378	376
Octocrylene +	2.5 + 2.5	10	381	380	380	379	379

TABLE 13-continued

Critical Wavelength

Critical Wavelength, CW			MED				
ADDITIVE:	Amount, g	#	0	5	10	15	20
1,2-Octanediol No additives (Negative Control)	0	11	380	377	370	364	362

As is evident from the above tables, in conjunction with graphs set forth in FIGS. 4 and 5, the composition with 2.5 g octocrylene and 2.5 g of 1,2 octanediol, provides better photostabilization of avobenzone than 5 g of octocrylene alone. Therefore, there is an unexpected synergistic effect on the photostabilization of avobenzone by using both octocrylene and 1,2 octanediol. Surprisingly, the UVB photostabilization is also achieved by the synergistic effect of the combination of octocrylene and 1,2 octanediol.

In addition, unexpectedly, the critical wavelength of the composition including the synergistic combination of octocrylene and 1,2 octanediol has been stabilized.

In another embodiment of the present invention, it has been surprisingly found that certain molar ratios of the one or more optimization agents according to the present invention to one or more dibenzoylmethane derivatives, such as avobenzone, results in a highly photostable composition.

Suitable molar ratio ranges for dibenzoylmethane derivative, according to the present invention are between about 0.016M to about 0.193M. Preferably, the molar range is between about 0.048M to about 0.096M. The dibenzoylmethane derivative is present in the composition in an amount about 0.5 wt. % to about 6 wt. %.

Suitable molar ratios for the one or more optimization agents to dibenzoylmethane derivative is between about 0.5 to about 400. Preferable, the molar ratio of one or more optimization agent to dibenzoylmethane derivative is about 0.5 to about 100 and more preferably about 0.5 to 10.

This embodiment of the present invention is demonstrated below in Example 6, with avobenzone as the dibenzoylmethane derivative.

EXAMPLE 6

In order to determine the impact of the concentration of avobenzone, from 0.04842 M to 0.0968 M (Factor 1) and different molar ratios of 1,2-octanediol (caprylyl glycol) to avobenzone, from 0 to 10 (Factor 2), on the photostability of avobenzone in the different sunscreen compositions, numerous studies were conducted. Three designs of experiments that represent central composite designs (CCDs) and D.O.E. Fusion 7.2.2 software were employed.

Experimental Set-Up

The CCD type of design was used to determine the effect of two factors: concentration of Avobenzone and the molar ratio 1,2-octanediol/avobenzone on the photostability of avobenzone in the different sunscreen compositions. Two responses were measured: the retained absorbance (%) of a sunscreen composition at 370 nm (UVA) and the same measurement at 310 nm (UVB) after irradiation dose of 15 MED.

TABLE 14

Ranges for the Two Experimental Factors

Factor	Range
Avobenzone Concentration	0.04842M to 0.0968M
Glycol/Avo Molar Ratio	0 to 10

Table 15 below presents the experimental CCD set-up used. The second column presents the experimental order in which the experiments were carried out, since order randomization is necessary

TABLE 15

Experimental CCD

Std	Run	Factor 1 A:Avobenzone M	Factor 2 B:Molar Ratio Glycol:Avo
1	8	0.055505	1.4645
2	10	0.089715	1.4645
3	7	0.055505	8.5355
4	12	0.089715	8.5355
5	1	0.04842	5
6	13	0.0968	5
7	6	0.07261	0
8	11	0.07261	10
9	3	0.07261	5
10	9	0.07261	5
11	4	0.07261	5
12	2	0.07261	5
13	5	0.07261	5

The same order of experiments was run in the different set-ups. As a result, two categorical factors were added: Oxybenzone (absent or present at a predetermined constant level) and Octocrylene (absent or present at a predetermined constant level). Table 16 presents the three set-ups as well as the numbers of the formulation tables and response tables.

TABLE 16

Full Experimental Runs

	Avobenzone and Glycol/Avo CCD	Oxybenzone	Octocrylene	Formulation Table	Results Table
DOE 1	Yes	Absent	Absent	Table 17	Table 18
DOE 2	Yes	Present	Absent	Table 19	Table 20
DOE 3	Yes	Present	Present	Table 21	Table 22

Response surface equalization were fitted to both responses (retained absorbance at 370 nm and retained absorbance at 310 nm, both after an irradiation dose of 15 MED). The significant factors were selected.

Response 1: Retained Absorbance at 370 nm after Irradiation at 15 MED

The response surface model indicates a high fit (R^2=0.9534). The presence of Oxybenzone in the system (model oil phase) gives the highest boost in retain absorbance at 370 nm and 15 MED exposure, as demonstrated by the graph in FIG. 6. An interaction between the presence of oxybenzone and the level of the glycol/avobenzone ratio was observed. This may suggest that at a high level of glycol/avobenzone oxybenzone may interact with the glycol and affect the stability of avobenzone.

There is a significant effect of the glycol/avobenzone ratio. This effect shows a statistically significant improvement in the measured response and it is stronger for lower concentration of avobenzone.

Higher concentrations of avobenzone help a better retention. The presence of octocrylene helps the absorbance retention 370 nm, but not as significant as in the case of oxybenzone. This effect seems to be enhanced at higher level glycol/avobenzone ratios. The graph of FIG. 7 demonstrates these results.

Response 2: Retain Absorbance at 310 nm after Irradiation at 15 MED

The response surface model indicates a moderate fit (R^2=0.6668). Oxybenzone helps retention at 310 nm where a mild jump in response especially at the lower levels of glycol/avobenzone ratio. Octocrylene also gives mild a gain in absorbency especially at higher levels of glycol/avobenzone and low levels of avobenzone. The higher concentration of avobenzone has a positive impact on the response, especially in the presence of octocrylene.

TABLE 17

DOE 1 Formulations

	RUN #:												
DOE 1	1	2	3	4	5	6	7	8	9	10	11	12	13
MODEL OF OIL PHASE:													
Homosalate	11	11	11	11	11	11	11	11	11	11	11	11	11
Octyl Salicylate	5	5	5	5	5	5	5	5	5	5	5	5	5
Avobenzone	1.5	2.3	2.3	2.3	2.3	2.3	1.7	1.7	2.3	2.8	2.3	2.8	3
1,2-Octanediol	3.5	5.3	5.3	5.3	5.3	0	6.9	1.2	5.3	1.9	10.6	11	7

TABLE 17-continued

DOE 1 Formulations

DOE 1	RUN #: 1	2	3	4	5	6	7	8	9	10	11	12	13
Neopentyl Glycol Diheptanoate QS to 30 g	9	6.4	6.4	6.4	6.4	11.7	5.4	11.1	6.4	9.3	1.1	0	4
	30	30	30	30	30	30	30	30	30	30	30	30	30

TABLE 18

UVA and UVB Photostabilization for DOE 1

DOE 1 Run	Factor 1 A:Avo, M	Factor 2 B:Molar Ratio Octanediol:Avo	Dielectic Constant 23 C.	Retained Abs, % at 370 nm after 15 MED	Retained Abs, % at 310 nm after 15 MED
1	0.04842	5	6.1	20	65
2	0.07261	5	6.64	25	73
3	0.07261	5	6.64	30	76
4	0.07261	5	6.64	29	79
5	0.07261	5	6.64	26	77
6	0.07261	0	5.58	13	61
7	0.055505	8.5355	6.78	26	67
8	0.055505	1.4645	5.69	17	62
9	0.07261	5	6.64	27	74
10	0.089715	1.4645	6.11	17	66
11	0.07261	10	7.8	33	77
12	0.089715	8.5355	8.08	24	72
13	0.0968	5	7.24	31	76

TABLE 19

DOE 2

DOE 2	RUN #: 1	2	3	4	5	6	7	8	9	10	11	12	13
MODEL OF OIL PHASE:													
Homosalate	11	11	11	11	11	11	11	11	11	11	11	11	11
Octyl Salicylate	5	5	5	5	5	5	5	5	5	5	5	5	5
Oxybenzone	6	6	6	6	6	6	6	6	6	6	6	6	6
Avobenzone	1.5	2.3	2.3	2.3	2.3	2.3	1.7	1.7	2.3	2.8	2.3	2.8	3
1,2-Octanediol	3.5	5.3	5.3	5.3	5.3	0	6.9	1.2	5.3	1.9	10.6	11	7
Neopentyl Glycol Diheptanoate QS to 36 g	9	6.4	6.4	6.4	6.4	11.7	5.4	11.1	6.4	9.3	1.1	0	4
	36	36	36	36	36	36	36	36	36	36	36	36	36

TABLE 20

UVA and UVB Photostabilization for DOE 2

DOE 2 Run	Factor 1 A:Avo, M	Factor 2 B:Molar Ratio Octanediol:Avo	Dielectic Constant 23 C.	Retained Abs, % at 370 after 15 MED	Retained Abs, % at 370 after 15 MED
1	0.04842	5	7.2	47	70
2	0.07261	5	7.7	62	81
3	0.07261	5	7.7	60	79
4	0.07261	5	7.7	62	80
5	0.07261	5	7.7	62	81
6	0.07261	0	6.7	44	63
7	0.055505	8.5355	7.9	56	75
8	0.055505	1.4645	6.7	51	74
9	0.07261	5	7.7	61	79
10	0.089715	1.4645	7.2	61	79
11	0.07261	10	8.7	58	78

TABLE 20-continued

UVA and UVB Photostabilization for DOE 2

DOE 2 Run	Factor 1 A:Avo, M	Factor 2 B:Molar Ratio Octanediol:Avo	Dielectic Constant 23 C.	Retained Abs, % at 370 after 15 MED	Retained Abs, % at 370 after 15 MED
12	0.089715	8.5355	8.9	51	66
13	0.0968	5	8.1	63	85

TABLE 21

DOE 3

	RUN #:												
DOE 3	1	2	3	4	5	6	7	8	9	10	11	12	13
MODEL OF OIL PHASE:													
Homosalate	11	11	11	11	11	11	11	11	11	11	11	11	11
Octyl Salicylate	5	5	5	5	5	5	5	5	5	5	5	5	5
Oxybenzone	6	6	6	6	6	6	6	6	6	6	6	6	6
Octocrylene	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Avobenzone	1.5	2.3	2.3	2.3	2.3	2.3	1.7	1.7	2.3	2.8	2.3	2.8	3
1,2-Octanediol	3.5	5.3	5.3	5.3	5.3	0	6.9	1.2	5.3	1.9	10.6	11	7
Neopentyl Glycol Diheptanoate QS to 38.5 g	9	6.4	6.4	6.4	6.4	11.7	5.4	11.1	6.4	9.3	1.1	0	4
	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5

TABLE 22

UVA and UVB Photostabilization for DOE 3

DOE 3 Run	Factor 1 A:Avo, M	Factor 2 B:Molar Ratio Octanediol:Avo	Dielectic Constant 23 C.	Retained Abs, % at 370 nm after 15 MED	Retained Abs, % at 310 nm after 15 MED
1	0.04842	5	7.40	54	78
2	0.07261	5	8.10	61	85
3	0.07261	5	8.10	63	79
4	0.07261	5	8.10	63	81
5	0.07261	5	8.10	63	81
6	0.07261	0	7.10	60	72
7	0.055505	8.5355	8.10	77	97
8	0.055505	1.4645	7.10	47	72
9	0.07261	5	8.10	63	81
10	0.089715	1.4645	7.40	60	70
11	0.07261	10	8.90	63	81
12	0.089715	8.5355	9.20	66	82
13	0.0968	5	8.50	62	75

The overall analysis of the results of DOE 1, 2 and 3 shows that 1,2-octanediol (caprylyl glycol) significantly improves the photostability of sunscreens at 310 nm (UVB sunscreens) and at 370 nm (UVA sunscreens such as Avobenzone). The concentration of avobenzone, molar ratio of 1,2-octanediol (caprylyl glycol) to avobenzone and also other sunscreens that are present in the sunscreen composition significantly influence the degree of photostabilization at 310 nm and 370 nm provided by 1,2-octanediol.

It should be understood that while many of the embodiments of the present invention were exemplified above through the testing and analysis of oil phases of a photoprotective composition, the unexpected results are even more enhanced in final photoprotective compositions (versus just an oil phase alone), due in part to the inclusion of additional components, such as those described below.

Additional Components

The one or more optimization agents are preferably included in a solvent system used to dissolve the one or more photoactive compounds. As used herein, a solvent system includes all of the compounds used to dissolve the one or more photoactive compounds. By way of example, the solvent system for cosmetic sunscreen compositions will include lipophilic compounds for dissolving oil miscible photoactive compounds and hydrophilic compounds for dissolving water miscible photoactive compounds. In a preferred embodiment, the solvent system includes one or more optimization agents that are both oil miscible and water miscible. Such agents offer a distinct advantage when formulating the sunscreen composition, as the need for separate oil and water miscible solvents is reduced or eliminated.

In addition to the one or more optimization agents, the solvent system may include, but is not limited to, one or more solvents, such as C_{12}–C_{15} alkyl benzoates, capric triglycerides, caprylic triglycerides, diethylhexyl adipate, diethylhexyl malate, diethylhexyl 2,6-naphthalate, ethylhexyl palmitate, ethylhexyl stearate, isoeicosane, isopropyl myristate, isopropyl palmitate, mineral oil, octyldodecyl neopentanoate, polyisobutene, PPG-2 myristyl ether propionate, cocoglycerides, isostearyl linoleate, diisopropyl adipate, myristyl ether myristate, octyl palmitate, propylene glycol ricinoleate, cetyl esters, propylene glycol laurate, or any combinations thereof. Although not necessary, it is preferred that the one or more solvents, when used with photoactive compounds such as those identified above, have a dielectric constant of about 1 to about 12. By using highly polar solvents, in addition to dissolving the one or more photoactive compounds, the solvents may contribute to the overall polarity of the composition.

In addition to the one or more photoactive compounds and the one or more optimizing agents, any well-known cosmetically-acceptable additives, such as, for example, water, emulsifier, thickening agent, emollient, SPF booster, moisturizer, humectant, film former/waterproofing agent, bioactive (functional) ingredient, pH adjuster/chelating agent, preservative, fragrance, effect pigment, color additive, lubricant, elastomer, or any combinations thereof, and/or other common cosmetic formulation additives for solubility of sunscreen active compounds, emulsification, thickening and to provide other skin enhancement, e.g., moisturizing properties, may be included in the sunscreen composition.

The compositions of the present invention preferably include water. The water is present in the compositions of the present invention in an amount about 40 wt. % to about 90 wt. %, and preferably about 50 wt. % to about 80 wt. %, of the total weight of the compositions.

The compositions of the present invention may include one or more emulsifiers. The one or more emulsifiers suitable for use in the present invention include, but are not limited to, acrylates crosspolymer, acrylates/C_{10-30} alkylacrylate crosspolymer, acrylates/vinyl isodecanoate crosspolymer, polyacrylic acid, sodium polymethacrylate, sodium polyacrylate, polyacrylates, cetyl alcohol, cetearyl alcohol, oleth-10, diethylhexyl esters, sorbitan oleate, sorbitan sesquioleate, sorbitan isostearate, sorbitan trioleate, PEG-20 almond glycerides, polyglyceryl-3-diisostearate, polyglycerol esters of oleic/isostearic acid, polyglyceryl-6 hexaricinolate, polyglyceryl-4-oleate, polygylceryl-4 oleate/PEG-8 propylene glycol cocoate, sodium glyceryl oleate phosphate, hydrogenated vegetable glycerides phosphate, or any combinations thereof.

The amount of emulsifier present in the compositions of the present invention is about 0.01 wt. % to about 10 wt. % of the total weight of the composition. Preferably, the emulsifier is present in an amount about 0.1 wt. % to about 5 wt. % of the total weight of the composition.

In an alternative embodiment, the sunscreen composition of the present invention may be formulated to be emulsifier free, which can improve water resistance of the sunscreen formulation and reduce its irritation potential.

One or more thickening agents that may be used in the compositions of the present invention. Suitable thickening agent includes, but is not limited to, one or more stabilizers, synthetic and natural gum or polymer products, polysaccharide thickening agents, associative thickeners, anionic associative rheology modifiers, nonionic associative rheology modifiers, oil-thickening agents, acrylates/C10–30 alkyl acrylate crosspolymer, acrylates/aminoacrylates/C10–30 alkyl PEG-20 itaconate copolymer, acrylates copolymer, acrylates/steareth-20 methacrylate copolymer, acrylates/beheneth-25 methacrylate copolymer, PEG-150/decyl alcohol/SMDI copolymer, PVP, PVM/MA decadiene crosspolymer, carbomer, PEG crosspolymer, acrylates/palmeth-25 acrylates copolymer, polysaccharides, polyacrylates, polyether-1, sodium magnesium silicate, sodium carbomer, sodium polyacrylate, sodium polymethacrylate, sodium polyacryloyldimethyl taurate, sodium acryloyldimethyl taurate copolymer, sodium carragenan, sodium carboxymethyl dextran, hydroxyethylcellulose, hydroxypropyl cyclodextran, bentonites, trihydroxystearin, aluminum-magnesium hydroxide stearate, xanthan gum, or any combinations thereof.

The amount of thickening agent present in the compositions of the present invention is about 0.01 wt. % to about 10 wt. % of the total weight of the composition. Preferably, the thickener is present in an amount about 0.1 wt. % to about 5 wt. % of the total weight of the composition.

The present compositions may include one or more emollients. An emollient provides a softening, protective or soothing effect on the skin surface and is generally considered safe for topical use. It also helps control the rate of evaporation and the tackiness of the compositions.

Suitable emollients include, for example, cocoglycerides, cyclomethicone, dimethicone, dicapryl maleate, caprylic/capric triglyceride, isopropyl myristate, octyl stearate, isostearyl linoleate, lanolin oil, coconut oil, cocoa butter, olive oil, avocado oil, aloe extracts, jojoba oil, castor oil, fatty acid such as oleic and stearic, fatty alcohol such as cetyl and hexadecyl, diisopropyl adipate, hydroxybenzoate esters, benzoic acid esters of C_9–C_{15} alcohols, isononyl isononanoate, alkanes such as mineral oil, silicone such as dimethyl polysiloxane, ether such as polyoxypropylene butyl ether and polyoxypropylene cetyl ether, C_{12}–C_{15} alkyl benzoate, or any combinations thereof.

The total amount of emollient present in the compositions is typically about 0.1 wt. % to about 30 wt. % of the total weight of the composition. Preferably, emollient is present in an amount about 1 wt. % to about 20 wt. % of the total weight of the composition.

The pH of the compositions of the present invention may be adjusted by one or more basic pH adjusters and/or chelating agents. For example, sodium hydroxide, triethanolamine, EDTA salts, or any combinations thereof are suitable pH adjusters/chelating agents that may be included in the sunscreen compositions of the present invention.

An effective amount of a pH adjuster and/or chelating agent is included to adjust the pH of the final compositions to about 3 to about 9. Preferably, the pH is adjusted to about 5 to about 8 and more preferably about 6 to about 7.

One or more humectants may be used in the compositions of the present invention. Suitable humectants include, but are not limited to, glycerin, pentylene glycol, hexylene glycol, propylene glycol, butylene glycol, sorbitol, PEG-4, or any combinations thereof.

One or more humectants may be included in the compositions of the present invention in an amount about 0.1 wt. % to about 15 wt. % of the total weight of the composition. Preferably, humectant is present in an amount about 1 wt. % to about 5 wt. % of the total weight of the composition. The present compositions may include one or more SPF boosters. SPF booster itself is not an active ingredient, but is designed to enhance the effectiveness of the sunscreen actives present in the formulation. Suitable SPF boosters include, but are not limited to, styrene/acrylates copolymer, sodium bentonites, highly purified white sodium bentonites, montmorillonite, hydrogels, fluorene derivatives, ester derivatives of cyano(9H-fluoren-9-ylidene), amides, malates, bis-urethanes, or any combinations thereof. A preferred styrene/acrylates copolymer for use in the present invention is sold under the trade name SunSpheres® by Rohm and Haas Company.

When present, the one or more SPF boosters may be included in the compositions of the present invention in an amount about 1 wt. % to about 6 wt. % of the total weight of the composition. Preferably, SPF booster is present in an amount about 2 wt. % to about 3 wt. % of the total weight of the composition.

Another component that may be used in the compositions of the present invention is a film former/waterproofing agent. The film former/waterproofing agent is a hydrophobic material that imparts film forming and waterproofing characteristics to the emulsion. Suitable film former/waterproof-

ing agent for use in the compositions of the present invention include, but is not limited to, acrylates/acrylamide copolymer, acrylates copolymer, acrylates/C_{12-22} alkylmethacrylate copolymer, polyethylene, waxes, VP/Dimethiconylacrylate/Polycarbamyl polyglycol ester, butylated PVP, PVP/Hexadecene copolymer, octadecene/MA copolymer, PVP/Eicosene copolymer, tricontanyl PVP, Brassica Campestris/Aleuritis Fordi Oil copolymer, decamethyl cyclopentasiloxane (and) trimethylsiloxysilicate, or any combinations thereof.

One or more film formers/waterproofing agents may be present in the compositions of the present invention in an amount about 0.1 wt. % to about 5 wt. % of the total weight of the composition. Preferably, the one or more film formers/waterproofing agents is present in the compositions of the present invention in an amount about 1 wt. % to about 3 wt. % of the total weight of the composition.

In addition, it has been unexpectedly found that the acrylates/C_{12-22} alkylmethacrylate copolymer may protect the lipids in a user's skin by imparting structure to the epidermal lipids in the skin (stratum corneum) and sebaceous lipids (sebum) and preventing them from depletion. As a result, it is believed that the acrylates/C_{12-22} alkylmethacrylate copolymer may enhance and help to maintain the barrier properties of the lipid barrier in stratum corneum.

Therefore, the compositions of the present invention may exhibit moisturizing and anti-inflammatory properties without a need for including moisturizers and/or anti-inflammatory agents in the compositions.

One or more preservatives may be included in the compositions of the present invention. The preservative protects the compositions from microbial contamination and/or oxidation. As such, the preservative can include an antioxidant. Preservatives, such as diazolidinyl urea, iodopropynyl butylcarbamate, chloromethylisotiazolinone, methylisothiazolinone, vitamin E and its derivatives including vitamin E acetate, vitamin C, butylated hydroxytoluene, butylparaben, ethylparaben, methylparaben, propylparaben, isobutylparaben, phenoxyethanol, or any mixtures thereof, may be included as a preservative in a composition of the present invention.

About 0.01 wt. % to about 2 wt. % of preservative may be included in a composition of the present invention. Preferably, one or more preservatives total about 0.5 wt. % to about 1.5 wt. % of the total weight of the composition.

The compositions of the present invention may also have other optional additives including bio-active (functional) ingredients. For instance, one or more plant extracts, fruit extracts, vegetable extracts, algae extracts, sugars, polysaccharides, lipids, proteins, peptides, aminoacids, aminoacid derivatives, absorbents, elastomers, for example DC 9011 silicone elastomer blend (Dow Corning) (cyclopentasiloxane (and) PEG-12 (and) dimethicone crosspolymer), salicylic acid, alpha and beta hydroxy acids, oil and water soluble vitamins including vitamins A, C, and E and their derivatives, or any mixtures thereof, may be included in the sunscreen compositions.

When present, the optional additives may be included in the present composition in an amount about 0.001 wt. % to about 10 wt. %, based on the total weight of the composition.

The compositions can be produced as lotions, creams, ointments, gels, solid sticks, emulsions, aerosols, solutions, dispersions, or any other forms of cosmetic compositions.

Further aspects of the invention may become apparent to those skilled in the art from a review of the detailed description set forth above. It should be understood that the disclosure is merely illustrative, and is not intended to limit the invention to the specific embodiments described.

We claim:

1. A photoprotective composition comprising:
one or more sunscreen agents; and
one or more optimizing agents selected from the group consisting of diol, alcohol, glycol, polyhydric alcohol, any derivatives thereof, and any combinations thereof,
wherein said photoprotective composition has one or more optimized properties selected from the group consisting of polarity, critical wavelength, SPF, PFA, Star Rating, photostability, and any combinations thereof, as compared to a composition without said one or more optimizing agents.

2. The photoprotective composition of claim 1, wherein said one or more sunscreen agents is selected from the group consisting of p-aminobenzoic acid, p-aminobenzoic acid salts, p-aminobenzoic acid derivatives, anthranilates, salicylates, glyceryl ester, dipropyleneglycol esters, cinnamic acid derivatives, dihydroxycinnamic acid derivatives, camphor, camphor derivatives, trihydroxycinnamic acid derivatives, hydrocarbons, dibenzalacetone, benzalacetophenone, naptholsulfonates, dihydroxy-naphthoic acid, dihydroxy-naphthoic acid salts; o-hydroxydiphenyldisulfonates, p-hydroxydiphenyldisulfonates, coumarin derivatives, diazoles, quinine salts, quinoline derivatives, hydroxy-substituted benzophenones, methoxy-substituted benzophenones, uric acids, vilouric acids, tannic acid, tannic acid derivatives, hydroquinone, benzophenones, avobenzone, 4-isopropyldibenzoylmethane, butylmethoxydibenzoylmethane, octocrylene, 4-isopropyl-dibenzoylmethane, metal oxides, titanium dioxide, zinc oxide, and any combinations thereof.

3. The photoprotective composition of claim 1, wherein said one or more sunscreen agents are present in an amount about 1 wt. % to about 40 wt. %, based on the total weight of the composition.

4. The photoprotective composition of claim 1, wherein said one or more optimizing agents are one or more diols, glycols, and any combinations thereof.

5. The photoprotective composition of claim 1, wherein said one or more optimizing agents are one or more glycols selected from the group consisting of pentylene glycol (1,2-pentanediol), neopentyl glycol (neopentanediol), caprylyl glycol (1,2-octanediol), ethoxydiglycol, butylene glycol monopropionate, diethylene glycol monobutyl ether, PEG-7 methyl ether, octacosanyl glycol, arachidyl glycol, benzyl glycol, cetyl glycol (1,2-hexanediol), C_{14-18} glycol, C_{15-18} glycol, lauryl glycol (1,2-dodecanediol), butoxydiglycol, 1,10-decanediol, ethyl hexanediol, or any combinations thereof.

6. The photoprotective composition of claim 1, wherein said one or more optimizing agents are one or more glycols selected from the group consisting of 1,2-pentanediol, 1,2-octanediol, and any combination thereof.

7. The photoprotective composition of claim 1, wherein said one or more optimizing agents is present in said composition in an amount about 0.1 wt. % to about 40 wt. %, based on the total weight of the composition.

8. The photoprotective composition of claim 1, wherein said one or more optimizing agents is present in said composition in an amount about 0.1 wt. % to about 10 wt. %, based on the total weight of the composition.

9. The photoprotective composition of claim 1, wherein said one or more optimizing agents, taken alone or in combination, has a dielectric constant greater than about 10.5.

10. The photoprotective composition of claim 1, wherein said one or more optimizing agents, taken alone or in combination, has a dielectric constant greater than about 13.

11. The photoprotective composition of claim 1, wherein said composition further comprises one or more components selected from the group consisting of solvent, water, emulsifier, thickening agent, emollient, SPF booster, moisturizer, humectant, film former/waterproofing agent, bio-active, pH adjuster/chelating agent, preservative, fragrance, effect pigment, color additive, lubricant, elastomer, and any combinations thereof.

12. A photoprotective composition comprising:

one or more sunscreen agents; and

one or more optimizing agents selected from the group consisting of diol, alcohol, glycol, polyhydric alcohol, any derivatives thereof, and any combinations thereof,

wherein said one or more optimizing agents, taken alone or in combination, has a dielectric constant greater than about 13.

13. The photoprotective composition of claim 12, wherein said one or more sunscreen agents is selected from the group consisting of p-aminobenzoic acid, p-aminobenzoic acid salts, p-aminobenzoic acid derivatives, anthranilates, salicylates, glyceryl ester, dipropyleneglycol esters, cinnamic acid derivatives, dihydroxycinnamic acid derivatives, camphor, camphor derivatives, trihydroxycinnamic acid derivatives, hydrocarbons, dibenzalacetone, benzalacetophenone, naptholsulfonates, dihydroxy-naphthoic acid, dihydroxy-naphthoic acid salts; o-hydroxydiphenyldisulfonates, p-hydroxydiphenyldisulfonates, coumarin derivatives, diazoles, quinine salts, quinoline derivatives, hydroxy-substituted benzophenones, methoxy-substituted benzophenones, uric acids, vilouric acids, tannic acid, tannic acid derivatives, hydroquinone, benzophenones, avobenzone, 4-isopropyldibenzoylmethane, butylmethoxydibenzoylmethane, octocrylene, 4-isopropyl-dibenzoylmethane, metal oxides, titanium dioxide, zinc oxide, and any combinations thereof.

14. The photoprotective composition of claim 12, wherein said one or more sunscreen agents are present in an amount about 1 wt. % to about 40 wt. %, based on the total weight of the composition.

15. The photoprotective composition of claim 12, wherein said one or more optimizing agents are one or more glycols selected from the group consisting of pentylene glycol, neopentyl glycol, caprylyl glycol, 1,2-octanediol, etoxydiglycol, butylene glycol monopropionate, diethylene glycol monobutyl ether, PEG-7 methyl ether, octacosanyl glycol, arachidyl glycol, benzyl glycol, cetyl glycol, C_{14-18} glycol, C_{15-18} glycol, lauryl glycol, butoxydiglycol, 1,10-decanediol, ethyl hexanediol, and any combinations thereof.

16. The photoprotective composition of claim 12, wherein said one or more optimizing agents are one or more glycols selected from the group consisting of 1,2-pentanediol, 1,2-octanediol, and any combination thereof.

17. The photoprotective composition of claim 12, wherein said one or more optimizing agents is present in said composition in an amount about 0.1 wt. % to about 40 wt. %, based on the total weight of the composition.

18. The photoprotective composition of claim 12, wherein said one or more optimizing agents is present in said composition in an amount about 0.1 wt. % to about 10 wt. %, based on the total weight of the composition.

19. The photoprotective composition of claim 12, wherein said composition further comprises one or more components selected from the group consisting of solvent, water, emulsifier, thickening agent, emollient, SPF booster, moisturizer, humectant, film former/waterproofing agent, bio-active, pH adjuster/chelating agent, preservative, fragrance, effect pigment, color additive, lubricant, elastomer, and any combinations thereof.

20. A photoprotective composition comprising:

one or more sunscreen agents; and

one or more optimizing agents selected from the group consisting of diol, alcohol, glycol, polyhydric alcohol, any derivatives thereof, and any combinations thereof,

wherein said one or more optimizing agents increase a SPF of said composition by at least 25% compared to a composition without said one or more optimizing agents.

21. The photoprotective composition of claim 20, wherein said one or more optimizing agents increase a SPF of said composition by at least about 30% compared to a composition without said one or more optimizing agents.

22. The photoprotective composition of claim 20, wherein said one or more sunscreen agents is selected from the group consisting of p-aminobenzoic acid, p-aminobenzoic acid salts, p-aminobenzoic acid derivatives, anthranilates, salicylates, glyceryl ester, dipropyleneglycol esters, cinnamic acid derivatives, dihydroxycinnamic acid derivatives, camphor, camphor derivatives, trihydroxycinnamic acid derivatives, hydrocarbons, dibenzalacetone, benzalacetophenone, naptholsulfonates, dihydroxy-naphthoic acid, dihydroxy-naphthoic acid salts; o-hydroxydiphenyldisulfonates, p-hydroxydiphenyldisulfonates, coumarin derivatives, diazoles, quinine salts, quinoline derivatives, hydroxy-substituted benzophenones, methoxy-substituted benzophenones, uric acids, vilouric acids, tannic acid, tannic acid derivatives, hydroquinone, benzophenones, avobenzone, 4-isopropyldibenzoyl methane, butylmethoxydibenzoylmethane, octocrylene, 4-isopropyl-dibenzoylmethane, metal oxides, titanium dioxide, zinc oxide, and any combinations thereof.

23. The photoprotective composition of claim 20, wherein said one or more sunscreen agents are present in an amount about 1 wt. % to about 40 wt. %, based on the total weight of the composition.

24. The photoprotective composition of claim 20, wherein said one or more optimizing agents are one or more glycols selected from the group consisting of pentylene glycol (1,2-pentanediol), neopentyl glycol (neopentanediol), caprylyl glycol (1,2-octanediol), ethoxydiglycol, butylene glycol monopropionate, diethylene glycol monobutyl ether, PEG-7 methyl ether, octacosanyl glycol, arachidyl glycol, benzyl glycol, cetyl glycol (1,2-hexanediol), C_{14-18} glycol, C_{15-18} glycol, lauryl glycol (1,2-dodecanediol), butoxydiglycol, 1,10-decanediol, ethyl hexanediol, or any combinations thereof.

25. The photoprotective composition of claim 20, wherein said one or more optimizing agents are one or more glycols selected from the group consisting of 1,2-pentanediol, 1,2-octanediol, and any combination thereof.

26. The photoprotective composition of claim 20, wherein said one or more optimizing agents is present in said composition in an amount about 0.1 wt. % to about 40 wt. %, based on the total weight of the composition.

27. The photoprotective composition of claim 20, wherein said one or more optimizing agents is present in said composition in an amount about 0.1 wt. % to about 10 wt. %, based on the total weight of the composition.

28. The photoprotective composition of claim 20, wherein said one or more optimizing agents, taken alone or in combination, has a dielectric constant greater than about 10.5.

29. The photoprotective composition of claim 20, wherein said one or more optimizing agents, taken alone or in combination, has a dielectric constant greater than about 13.

30. The photoprotective composition of claim 20, wherein said composition further comprises one or more components selected from the group consisting of solvent, water, emulsifier, thickening agent, emollient, SPF booster, moisturizer, humectant, film former/waterproofing agent, bio-active, pH adjuster/chelating agent, preservative, fragrance, effect pigment, color additive, lubricant, elastomer, and any combinations thereof.

31. A photoprotective composition comprising:

one or more sunscreen agents; and

one or more optimizing agents selected from the group consisting of diol, alcohol, glycol, polyhydric alcohol, any derivatives thereof, and any combinations thereof,

wherein said one or more optimizing agents increase a PFA of said composition by at least 10% compared to a composition without said one or more optimizing agents.

32. The photoprotective composition of claim 31, wherein said one or more optimizing agents increase a PFA of said composition by at least about 85% compared to a composition without said one or more optimizing agents.

33. The photoprotective composition of claim 31, wherein said one or more sunscreen agents is selected from the group consisting of p-aminobenzoic acid, p-aminobenzoic acid salts, p-aminobenzoic acid derivatives, anthranilates, salicylates, glyceryl ester, dipropyleneglycol esters, cinnamic acid derivatives, dihydroxycinnamic acid derivatives, camphor, camphor derivatives, trihydroxycinnamic acid derivatives, hydrocarbons, dibenzalacetone, benzalacetophenone, naptholsulfonates, dihydroxy-naphthoic acid, dihydroxy-naphthoic acid salts; o-hydroxydiphenyldisulfonates, p-hydroxydiphenyldisulfonates, coumarin derivatives, diazoles, quinine salts, quinoline derivatives, hydroxy-substituted benzophenones, methoxy-substituted benzophenones, uric acids, vilouric acids, tannic acid, tannic acid derivatives, hydroquinone, benzophenones, avobenzone, 4-isopropyldibenzoylmethane, butylmethoxydibenzoylmethane, octocrylene, 4-isopropyl-dibenzoylmethane, metal oxides, titanium dioxide, zinc oxide, and any combinations thereof.

34. The photoprotective composition of claim 31, wherein said one or more sunscreen agents are present in an amount about 1 wt. % to about 40 wt. %, based on the total weight of the composition.

35. The photoprotective composition of claim 31, wherein said one or more optimizing agents are one or more glycols selected from the group consisting of pentylene glycol (1,2-pentanediol), neopentyl glycol (neopentanediol), caprylyl glycol (1,2-octanediol), ethoxydiglycol, butylene glycol monopropionate, diethylene glycol monobutyl ether, PEG-7 methyl ether, octacosanyl glycol, arachidyl glycol, benzyl glycol, cetyl glycol (1,2-hexanediol), C_{14-18} glycol, C_{15-18} glycol, lauryl glycol (1,2-dodecanediol), butoxydiglycol, 1,10-decanediol, ethyl hexanediol, or any combinations thereof.

36. The photoprotective composition of claim 31, wherein said one or more optimizing agents are one or more glycols selected from the group consisting of 1,2-pentanediolpentylene glycol, 1,2-octanediol, and any combination thereof.

37. The photoprotective composition of claim 31, wherein said one or more optimizing agents is present in said composition in an amount about 0.1 wt. % to about 40 wt. %, based on the total weight of the composition.

38. The photoprotective composition of claim 31, wherein said one or more optimizing agents is present in said composition in an amount about 0.1 wt. % to about 10 wt. %, based on the total weight of the composition.

39. The photoprotective composition of claim 31, wherein said one or more optimizing agents, taken alone or in combination, has a dielectric constant greater than about 10.5.

40. The photoprotective composition of claim 31, wherein said one or more optimizing agents, taken alone or in combination, has a dielectric constant greater than about 13.

41. The photoprotective composition of claim 31, wherein said composition further comprises one or more components selected from the group consisting of solvent, water, emulsifier, thickening agent, emollient, SPF booster, moisturizer, humectant, film former/waterproofing agent, bio-active, pH adjuster/chelating agent, preservative, fragrance, effect pigment, color additive, lubricant, elastomer, and any combinations thereof.

42. A photoprotective composition comprising:

a synergistic combination of octocrylene and one or more optimizing agents selected from the group consisting of diol, alcohol, glycol, polyhydric alcohol, any derivatives thereof, and any combinations thereof,

wherein, as a result of said synergistic combination, said photoprotective composition has an increase in a UVA photostability of at least about 10%, an increase in a UVB photostability of at least about 10% and a decrease in a critical wavelength as compared to a composition without said synergistic combination of octocrylene and one or more optimizing agents.

43. The photoprotective composition of claim 42, wherein said synergistic combination of one or more optimizing agents and octocrylene is present in a weight ratio of one or more optimizing agents to octocrylene of about 0.1 to about 10.

44. The photoprotective composition of claim 42, further comprising one or more sunscreen agents selected from the group consisting of p-aminobenzoic acid, p-aminobenzoic acid salts, p-aminobenzoic acid derivatives, anthranilates, salicylates, glyceryl ester, dipropyleneglycol esters, cinnamic acid derivatives, dihydroxycinnamic acid derivatives, camphor, camphor derivatives, trihydroxycinnamic acid derivatives, hydrocarbons, dibenzalacetone, benzalacetophenone, naptholsulfonates, dihydroxy-naphthoic acid, dihydroxy-naphthoic acid salts; o-hydroxydiphenyldisulfonates, p-hydroxydiphenyldisulfonates, coumarin derivatives, diazoles, quinine salts, quinoline derivatives, hydroxy-substituted benzophenones, methoxy-substituted benzophenones, uric acids, vilouric acids, tannic acid, tannic acid derivatives, hydroquinone, benzophenones, avobenzone, 4-isopropyldibenzoylmethane, butylmethoxydibenzoylmethane, 4-isopropyldibenzoylmethane, metal oxides, titanium dioxide, zinc oxide, and any combinations thereof.

45. The photoprotective composition of claim 44, wherein said one or more sunscreen agents are present in an amount about 1 wt. % to about 40 wt. %, based on the total weight of the composition.

46. The photoprotective composition of claim 42, wherein said one or more optimizing agents are one or more glycols selected from the group consisting of pentylene glycol (1,2-pentanediol), neopentyl glycol (neopentanediol), caprylyl glycol (1,2-octanediol), ethoxydiglycol, butylene glycol monopropionate, diethylene glycol monobutyl ether, PEG-7 methyl ether, octacosanyl glycol, arachidyl glycol, benzyl glycol, cetyl glycol (1,2-hexanediol), C_{14-18} glycol, C_{15-18} glycol, lauryl glycol (1,2-dodecanediol), butoxydiglycol, 1,10-decanediol, ethyl hexanediol, or any combinations thereof.

47. The photoprotective composition of claim 42, wherein said one or more optimizing agents are one or more glycols selected from the group consisting of 1,2-pentanediol, 1,2-octanediol, and any combination thereof.

48. The photoprotective composition of claim 42, wherein said one or more optimizing agents is present in said composition in an amount about 0.1 wt. % to about 40 wt. %, based on the total weight of the composition.

49. The photoprotective composition of claim 42, wherein said one or more optimizing agents is present in said composition in an amount about 0.1 wt. % to about 10 wt. %, based on the total weight of the composition.

50. The photoprotective composition of claim 42, wherein said composition further comprises one or more components selected from the group consisting of solvent, water, emulsifier, thickening agent, emollient, SPF booster, moisturizer, humectant, film former/waterproofing agent, bio-active, pH adjuster/chelating agent, preservative, fragrance, effect pigment, color additive, lubricant, elastomer, and any combinations thereof.

51. A photoprotective composition comprising:

one or more dibenzoylmethane derivatives;

one or more additional sunscreen agents; and

one or more optimizing agents selected from the group consisting of diol, alcohol, glycol, polyhydric alcohol, any derivatives thereof, and any combinations thereof,

wherein said one or more dibenzoylmethane derivatives is present in a molar concentration between about 0.016 M to about 0.193 M, and

wherein said one or more optimizing agents to said one or more dibenzoylmethane derivatives are present in said composition in a molar ratio of about 0.5 to about 400.

52. The photoprotective composition of claim 51, wherein said one or more dibenzoylmethane derivatives is present in a molar concentration between about 0.048 M to about 0.096 M.

53. The photoprotective composition of claim 51, wherein said one or more optimizing agents to said one or more dibenzoylmethane derivatives are present in said composition in a molar ratio of about 0.5 to about 10.

54. The photoprotective composition of claim 51, wherein said one or more dibenzoylmethane derivatives is selected from the group consisting of avobenzone, 4-isopropyldibenzoylmethane, butylmethoxydibenzoylmethane, 4-isopropyldibenzoylmethane, and any combinations thereof.

55. The photoprotective composition of claim 51, wherein said one or more additional sunscreen agents are selected from the group consisting of p-aminobenzoic acid, p-aminobenzoic acid salts, p-aminobenzoic acid derivatives, anthranilates, salicylates, glyceryl ester, dipropyleneglycol esters, cinnamic acid derivatives, dihydroxycinnamic acid derivatives, camphor, camphor derivatives, trihydroxycinnamic acid derivatives, hydrocarbons, dibenzalacetone, benzalacetophenone, naptholsulfonates, dihydroxy-naphthoic acid, dihydroxy-naphthoic acid salts; o-hydroxydiphenyldisulfonates, p-hydroxydiphenyldisulfonates, coumarin derivatives, diazoles, quinine salts, quinoline derivatives, hydroxy-substituted benzophenones, methoxy-substituted benzophenones, uric acids, vilouric acids, tannic acid, tannic acid derivatives, hydroquinone, benzophenones, octocrylene, metal oxides, titanium dioxide, zinc oxide, and any combinations thereof.

56. The photoprotective composition of claim 51, wherein said one or more dibenzoylmethane derivatives are present in an amount about 0.5 wt. % to about 6 wt. %, based on the total weight of the composition.

57. The photoprotective composition of claim 51, wherein said one or more additional sunscreen agents are present in an amount about 1 wt. % to about 40 wt. %, based on the total weight of the composition.

58. The photoprotective composition of claim 51, wherein said one or more optimizing agents are one or more glycols selected from the group consisting of pentylene glycol (1,2-pentanediol), neopentyl glycol (neopentanediol), caprylyl glycol (1,2-octanediol), ethoxydiglycol, butylene glycol monopropionate, diethylene glycol monobutyl ether, PEG-7 methyl ether, octacosanyl glycol, arachidyl glycol, benzyl glycol, cetyl glycol (1,2-hexanediol), C_{14-18} glycol, C_{15-18} glycol, lauryl glycol (1,2-dodecanediol), butoxydiglycol, 1,10-decanediol, ethyl hexanediol, or any combinations thereof.

59. The photoprotective composition of claim 51, wherein said one or more optimizing agents are one or more glycols selected from the group consisting of 1,2-pentanediol, 1,2-octanediol, and any combination thereof.

60. The photoprotective composition of claim 51, wherein said one or more optimizing agents is present in said composition in an amount about 0.1 wt. % to about 40 wt. %, based on the total weight of the composition.

61. The photoprotective composition of claim 51, wherein said one or more optimizing agents is present in said composition in an amount about 0.1 wt. % to about 10 wt. %, based on the total weight of the composition.

62. The photoprotective composition of claim 51, wherein said composition further comprises one or more components selected from the group consisting of solvent, water, emulsifier, thickening agent, emollient, SPF booster, moisturizer, humectant, film former/waterproofing agent, bio-active, pH adjuster/chelating agent, preservative, fragrance, effect pigment, color additive, lubricant, elastomer, and any combinations thereof.

63. A photoprotective composition comprising:

one or more sunscreen agents; and

one or more optimizing agents selected from the group consisting of 1,2-octanediol, 1,2-pentanediol, and combinations thereof,

wherein said one or more optimizing agents optimizes one or more properties selected from the group consisting of polarity, critical wavelength, SPF, PFA, Star Rating, photostability, and any combinations thereof, of said composition, as compared to a composition without said one or more optimizing agents.

64. The photoprotective composition of claim 63, wherein said one or more sunscreen agents is selected from the group consisting of p-aminobenzoic acid, p-aminobenzoic acid salts, p-aminobenzoic acid derivatives, anthranilates, salicylates, glyceryl ester, dipropyleneglycol esters, cinnamic acid derivatives, dihydroxycinnamic acid derivatives, camphor, camphor derivatives, trihydroxycinnamic acid derivatives, hydrocarbons, dibenzalacetone, benzalacetophenone, naptholsulfonates, dihydroxy-naphthoic acid, dihydroxy-naphthoic acid salts; o-hydroxydiphenyldisulfonates, p-hydroxydiphenyldisulfonates, coumarin derivatives, diazoles, quinine salts, quinoline derivatives, hydroxy-substituted benzophenones, methoxy-substituted benzophenones, uric acids, vilouric acids, tannic acid, tannic acid derivatives, hydroquinone, benzophenones, avobenzone, 4-isopropyldibenzoylmethane, butylmethoxydibenzoylmethane, octocrylene, 4-isopropyl-dibenzoylmethane, metal oxides, titanium dioxide, zinc oxide, and any combinations thereof.

65. The photoprotective composition of claim 63, wherein said one or more sunscreen agents are present in an amount about 1 wt. % to about 40 wt. %, based on the total weight of the composition.

66. The photoprotective composition of claim 63, wherein said one or more optimizing agents is present in said composition in an amount about 0.1 wt. % to about 40 wt. %, based on the total weight of the composition.

67. The photoprotective composition of claim 63, wherein said one or more optimizing agents is present in said composition in an amount about 0.1 wt. % to about 10 wt. %, based on the total weight of the composition.

68. The photoprotective composition of claim 63, wherein said composition further comprises one or more components selected from the group consisting of solvent, water, emulsifier, thickening agent, emollient, SPF booster, moisturizer, humectant, film former/waterproofing agent, bio-active, pH adjuster/chelating agent, preservative, fragrance, effect pigment, color additive, lubricant, elastomer, and any combinations thereof.

69. A method of providing an efficient photoprotective composition comprising the steps of:

formulating a photoprotective composition with one or more sunscreen agents and one or more optimizing agents selected from the group consisting of diol, alcohol, glycol, polyhydric alcohol, any derivatives thereof, and any combinations thereof,

wherein said photoprotective composition has one or more optimized properties selected from the group consisting of polarity, critical wavelength, SPF, PFA, Star Rating, photostability, and any combinations thereof, as compared to a composition without said one or more optimizing agents.

70. The method of claim 69, wherein said one or more sunscreen agents is selected from the group consisting of p-aminobenzoic acid, p-aminobenzoic acid salts, p-aminobenzoic acid derivatives, anthranilates, salicylates, glyceryl ester, dipropyleneglycol esters, cinnamic acid derivatives, dihydroxycinnamic acid derivatives, camphor, camphor derivatives, trihydroxycinnamic acid derivatives, hydrocarbons, dibenzalacetone, benzalacetophenone, naptholsulfonates, dihydroxy-naphthoic acid, dihydroxy-naphthoic acid salts; o-hydroxydiphenyldisulfonates, p-hydroxydiphenyldisulfonates, coumarin derivatives, diazoles, quinine salts, quinoline derivatives, hydroxy-substituted benzophenones, methoxy-substituted benzophenones, uric acids, vilouric acids, tannic acid, tannic acid derivatives, hydroquinone, benzophenones, avobenzone, 4-isopropyldibenzoylmethane, butylmethoxydibenzoylmethane, octocrylene, 4-isopropyl-dibenzoylmethane, metal oxides, titanium dioxide, zinc oxide, and any combinations thereof.

71. The method of claim 69, wherein said one or more sunscreen agents are present in an amount about 1 wt. % to about 40 wt. %, based on the total weight of the composition.

72. The method of claim 69, wherein said one or more optimizing agents are one or more glycols selected from the group consisting of pentylene glycol (1,2-pentanediol), neopentyl glycol (neopentanediol), caprylyl glycol (1,2-octanediol), ethoxydiglycol, butylene glycol monopropionate, diethylene glycol monobutyl ether, PEG-7 methyl ether, octacosanyl glycol, arachidyl glycol, benzyl glycol, cetyl glycol (1,2-hexanediol), C_{14-18} glycol, C_{15-18} glycol, lauryl glycol (1,2-dodecanediol), butoxydiglycol, 1,10-decanediol, ethyl hexanediol, or any combinations thereof.

73. The method of claim 69, wherein said one or more optimizing agents are one or more glycols selected from the group consisting of pentylene glycol, 1,2-octanediol, and any combination thereof.

74. The method of claim 69, wherein said one or more optimizing agents is present in said composition in an amount about 0.1 wt. % to about 40 wt. %, based on the total weight of the composition.

75. The method of claim 69, wherein said one or more optimizing agents is present in said composition in an amount about 0.1 wt. % to about 10 wt. %, based on the total weight of the composition.

76. The method of claim 69, wherein said one or more optimizing agents, taken alone or in combination, has a dielectric constant greater than about 10.5.

77. The method of claim 69, wherein said one or more optimizing agents, taken alone or in combination, has a dielectric constant greater than about 13.

78. The method of claim 69, wherein said composition further comprises one or more components selected from the group consisting of solvent, water, emulsifier, thickening agent, emollient, SPF booster, moisturizer, humectant, film former/waterproofing agent, bio-active, pH adjuster/chelating agent, preservative, fragrance, effect pigment, color additive, lubricant, elastomer, and any combinations thereof.

79. A method for optimizing a polarity, critical wavelength, SPF, PFA, Star Rating, photostability, or any combinations thereof, in a photoprotective composition comprising the step of:

formulating said photoprotective composition with one or more sunscreen agents and one or more optimizing agents selected from the group consisting of diol, alcohol, glycol, polyhydric alcohol, any derivatives thereof, and any combinations thereof,

wherein said photoprotective composition has one or more optimized properties selected from the group consisting of polarity, critical wavelength, SPF, PFA, Star Rating, photostability, and any combinations thereof, as compared to a composition without said one or more optimizing agents.

80. The method of claim 79, wherein said one or more sunscreen agents is selected from the group consisting of p-aminobenzoic acid, p-aminobenzoic acid salts, p-aminobenzoic acid derivatives, anthranilates, salicylates, glyceryl ester, dipropyleneglycol esters, cinnamic acid derivatives, dihydroxycinnamic acid derivatives, camphor, camphor derivatives, trihydroxycinnamic acid derivatives, hydrocarbons, dibenzalacetone, benzalacetophenone, naptholsulfonates, dihydroxy-naphthoic acid, dihydroxy-naphthoic acid salts; o-hydroxydiphenyldisulfonates, p-hydroxydiphenyldisulfonates, coumarin derivatives, diazoles, quinine salts, quinoline derivatives, hydroxy-substituted benzophenones, methoxy-substituted benzophenones, uric acids, vilouric acids, tannic acid, tannic acid derivatives, hydroquinone, benzophenones, avobenzone, 4-isopropyldibenzoylmethane, butylmethoxydibenzoylmethane, octocrylene, 4-isopropyldibenzoylmethane, metal oxides, titanium dioxide, zinc oxide, and any combinations thereof.

81. The method of claim 79, wherein said one or more sunscreen agents are present in an amount about 1 wt. % to about 40 wt. %, based on the total weight of the composition.

82. The method of claim 79, wherein said one or more optimizing agents are one or more glycols selected from the group consisting of pentylene glycol (1,2-pentanediol), neopentyl glycol (neopentanediol), caprylyl glycol (1,2-octanediol), ethoxydiglycol, butylene glycol monopropionate, diethylene glycol monobutyl ether, PEG-7 methyl ether,

octacosanyl glycol, arachidyl glycol, benzyl glycol, cetyl glycol (1,2-hexanediol), C_{14-18} glycol, C_{15-18} glycol, lauryl glycol (1,2-dodecanediol), butoxydiglycol, 1,10-decanediol, ethyl hexanediol, or any combinations thereof.

83. The method of claim **79**, wherein said one or more optimizing agents are one or more glycols selected from the group consisting of 1,2-pentanediol, pentylene glycol, 1,2-octanediol, and any combination thereof.

84. The method of claim **79**, wherein said one or more optimizing agents is present in said composition in an amount about 0.1 wt. % to about 40 wt. %, based on the total weight of the composition.

85. The method of claim **79**, wherein said one or more optimizing agents is present in said composition in an amount about 0.1 wt. % to about 10 wt. %, based on the total weight of the composition.

86. The method of claim **79**, wherein said one or more optimizing agents, taken alone or in combination, has a dielectric constant greater than about 10.5.

87. The method of claim **79**, wherein said one or more optimizing agents, taken alone or in combination, has a dielectric constant greater than about 13.

88. The method of claim **79**, wherein said composition further comprises one or more components selected from the group consisting of solvent, water, emulsifier, thickening agent, emollient, SPF booster, moisturizer, humectant, film former/waterproofing agent, bio-active, pH adjuster/chelating agent, preservative, fragrance, effect pigment, color additive, lubricant, elastomer, and any combinations thereof.

89. The photoprotective composition according to claim **1**, further comprising an oil-phase, wherein said one or more optimizing agents are in said oil-phase.

90. The photoprotective composition according to claim **12**, further comprising an oil-phase, wherein said one or more optimizing agents are in said oil-phase.

91. The photoprotective composition according to claim **20**, further comprising an oil-phase, wherein said one or more optimizing agents are in said oil-phase.

92. The photoprotective composition according to claim **63**, further comprising an oil-phase, wherein said one or more optimizing agents are in said oil-phase.

93. The photoprotective composition according to claim **69**, further comprising an oil-phase, wherein said one or more optimizing agents are in said oil-phase.

94. The photoprotective composition according to claim **79**, further comprising an oil-phase, wherein said one or more optimizing agents are in said oil-phase.

* * * * *

EXHIBIT B

Exhibit B

Banana Boat® Ultramist™ Kids Tear-Free™ Continuous Lotion Spray SPF 50

EXHIBIT C

Exhibit C

FOTE Kids Sunscreen Continuous Spray Lotion

JS 44 (Rev. 11/04)

CIVIL COVER SHEET

The JS 44 civil cover sheet and the information contained herein neither replace nor supplement the filing and service of pleadings or other papers as required by law, except as provided by local rules of court. This form, approved by the Judicial Conference of the United States in September 1974, is required for the use of the Clerk of Court for the purpose of initiating the civil docket sheet. (SEE INSTRUCTIONS ON THE REVERSE OF THE FORM.)

I. (a) PLAINTIFFS
PLAYTEX PRODUCTS, INC.

DEFENDANTS
FRUIT OF THE EARTH, INC.

(b) County of Residence of First Listed Plaintiff _____
(EXCEPT IN U.S. PLAINTIFF CASES)

County of Residence of First Listed Defendant _____
(IN U.S. PLAINTIFF CASES ONLY)
NOTE: IN LAND CONDEMNATION CASES, USE THE LOCATION OF THE LAND INVOLVED.

(c) Attorney's (Firm Name, Address, and Telephone Number)
Maryellen Noreika, MORRIS, NICHOLS, ARSHT & TUNNELL LLP,
1201 North Market Street, P.O. Box 1347,
Wilmington, DE 19899-1347, (302) 658-9200

Attorneys (If Known)

II. BASIS OF JURISDICTION (Place an "X" in One Box Only)

- ☐ 1 U.S. Government Plaintiff
- ☒ 3 Federal Question (U.S. Government Not a Party)
- ☐ 2 U.S. Government Defendant
- ☐ 4 Diversity (Indicate Citizenship of Parties in Item III)

III. CITIZENSHIP OF PRINCIPAL PARTIES (Place an "X" in One Box for Plaintiff and One Box for Defendant)
(For Diversity Cases Only)

	PTF	DEF		PTF	DEF
Citizen of This State	☐ 1	☐ 1	Incorporated *or* Principal Place of Business In This State	☐ 4	☐ 4
Citizen of Another State	☐ 2	☐ 2	Incorporated *and* Principal Place of Business In Another State	☐ 5	☐ 5
Citizen or Subject of a Foreign Country	☐ 3	☐ 3	Foreign Nation	☐ 6	☐ 6

IV. NATURE OF SUIT (Place an "X" in One Box Only)

CONTRACT	TORTS		FORFEITURE/PENALTY	BANKRUPTCY	OTHER STATUTES
☐ 110 Insurance	PERSONAL INJURY	PERSONAL INJURY	☐ 610 Agriculture	☐ 422 Appeal 28 USC 158	☐ 400 State Reapportionment
☐ 120 Marine	☐ 310 Airplane	☐ 362 Personal Injury - Med. Malpractice	☐ 620 Other Food & Drug	☐ 423 Withdrawal 28 USC 157	☐ 410 Antitrust
☐ 130 Miller Act	☐ 315 Airplane Product Liability	☐ 365 Personal Injury - Product Liability	☐ 625 Drug Related Seizure of Property 21 USC 881		☐ 430 Banks and Banking
☐ 140 Negotiable Instrument	☐ 320 Assault, Libel & Slander	☐ 368 Asbestos Personal Injury Product Liability	☐ 630 Liquor Laws	PROPERTY RIGHTS	☐ 450 Commerce
☐ 150 Recovery of Overpayment & Enforcement of Judgment	☐ 330 Federal Employers' Liability	PERSONAL PROPERTY	☐ 640 R.R. & Truck	☐ 820 Copyrights	☐ 460 Deportation
☐ 151 Medicare Act	☐ 340 Marine	☐ 370 Other Fraud	☐ 650 Airline Regs.	☒ 830 Patent	☐ 470 Racketeer Influenced and Corrupt Organizations
☐ 152 Recovery of Defaulted Student Loans (Excl. Veterans)	☐ 345 Marine Product Liability	☐ 371 Truth in Lending	☐ 660 Occupational Safety/Health	☐ 840 Trademark	☐ 480 Consumer Credit
☐ 153 Recovery of Overpayment of Veteran's Benefits	☐ 350 Motor Vehicle	☐ 380 Other Personal Property Damage	☐ 690 Other		☐ 490 Cable/Sat TV
☐ 160 Stockholders' Suits	☐ 355 Motor Vehicle Product Liability	☐ 385 Property Damage Product Liability	LABOR	SOCIAL SECURITY	☐ 810 Selective Service
☐ 190 Other Contract	☐ 360 Other Personal Injury		☐ 710 Fair Labor Standards Act	☐ 861 HIA (1395ff)	☐ 850 Securities/Commodities/ Exchange
☐ 195 Contract Product Liability			☐ 720 Labor/Mgmt. Relations	☐ 862 Black Lung (923)	☐ 875 Customer Challenge 12 USC 3410
☐ 196 Franchise			☐ 730 Labor/Mgmt.Reporting & Disclosure Act	☐ 863 DIWC/DIWW (405(g))	☐ 890 Other Statutory Actions
REAL PROPERTY	CIVIL RIGHTS	PRISONER PETITIONS	☐ 740 Railway Labor Act	☐ 864 SSID Title XVI	☐ 891 Agricultural Acts
☐ 210 Land Condemnation	☐ 441 Voting	☐ 510 Motions to Vacate Sentence	☐ 790 Other Labor Litigation	☐ 865 RSI (405(g))	☐ 892 Economic Stabilization Act
☐ 220 Foreclosure	☐ 442 Employment	Habeas Corpus:	☐ 791 Empl. Ret. Inc. Security Act	FEDERAL TAX SUITS	☐ 893 Environmental Matters
☐ 230 Rent Lease & Ejectment	☐ 443 Housing/ Accommodations	☐ 530 General		☐ 870 Taxes (U.S. Plaintiff or Defendant)	☐ 894 Energy Allocation Act
☐ 240 Torts to Land	☐ 444 Welfare	☐ 535 Death Penalty		☐ 871 IRS—Third Party 26 USC 7609	☐ 895 Freedom of Information Act
☐ 245 Tort Product Liability	☐ 445 Amer. w/Disabilities - Employment	☐ 540 Mandamus & Other			☐ 900Appeal of Fee Determination Under Equal Access to Justice
☐ 290 All Other Real Property	☐ 446 Amer. w/Disabilities - Other	☐ 550 Civil Rights			☐ 950 Constitutionality of State Statutes
	☐ 440 Other Civil Rights	☐ 555 Prison Condition			

V. ORIGIN (Place an "X" in One Box Only)

☒ 1 Original Proceeding ☐ 2 Removed from State Court ☐ 3 Remanded from Appellate Court ☐ 4 Reinstated or Reopened ☐ 5 Transferred from another district (specify) ☐ 6 Multidistrict Litigation ☐ 7 Appeal to District Judge from Magistrate Judgment

VI. CAUSE OF ACTION
Cite the U.S. Civil Statute under which you are filing (**Do not cite jurisdictional statutes unless diversity**):
35 U.S.C. § 271
Brief description of cause:
patent infringement

VII. REQUESTED IN COMPLAINT: ☐ CHECK IF THIS IS A CLASS ACTION UNDER F.R.C.P. 23 DEMAND $ CHECK YES only if demanded in complaint: JURY DEMAND: ☒ Yes ☐ No

VIII. RELATED CASE(S) IF ANY (See instructions): JUDGE _____ DOCKET NUMBER _____

DATE 4/16/08 SIGNATURE OF ATTORNEY OF RECORD Maryellen Noreika

FOR OFFICE USE ONLY

RECEIPT # _____ AMOUNT _____ APPLYING IFP _____ JUDGE _____ MAG. JUDGE _____

JS 44 Reverse (Rev. 11/04)

INSTRUCTIONS FOR ATTORNEYS COMPLETING CIVIL COVER SHEET FORM JS 44

Authority For Civil Cover Sheet

The JS 44 civil cover sheet and the information contained herein neither replaces nor supplements the filings and service of pleading or other papers as required by law, except as provided by local rules of court. This form, approved by the Judicial Conference of the United States in September 1974, is required for the use of the Clerk of Court for the purpose of initiating the civil docket sheet. Consequently, a civil cover sheet is submitted to the Clerk of Court for each civil complaint filed. The attorney filing a case should complete the form as follows:

I. (a) Plaintiffs-Defendants. Enter names (last, first, middle initial) of plaintiff and defendant. If the plaintiff or defendant is a government agency, use only the full name or standard abbreviations. If the plaintiff or defendant is an official within a government agency, identify first the agency and then the official, giving both name and title.

(b) County of Residence. For each civil case filed, except U.S. plaintiff cases, enter the name of the county where the first listed plaintiff resides at the time of filing. In U.S. plaintiff cases, enter the name of the county in which the first listed defendant resides at the time of filing. (NOTE: In land condemnation cases, the county of residence of the "defendant" is the location of the tract of land involved.)

(c) Attorneys. Enter the firm name, address, telephone number, and attorney of record. If there are several attorneys, list them on an attachment, noting in this section "(see attachment)".

II. Jurisdiction. The basis of jurisdiction is set forth under Rule 8(a), F.R.C.P., which requires that jurisdictions be shown in pleadings. Place an "X" in one of the boxes. If there is more than one basis of jurisdiction, precedence is given in the order shown below.

United States plaintiff. (1) Jurisdiction based on 28 U.S.C. 1345 and 1348. Suits by agencies and officers of the United States are included here.

United States defendant. (2) When the plaintiff is suing the United States, its officers or agencies, place an "X" in this box.

Federal question. (3) This refers to suits under 28 U.S.C. 1331, where jurisdiction arises under the Constitution of the United States, an amendment to the Constitution, an act of Congress or a treaty of the United States. In cases where the U.S. is a party, the U.S. plaintiff or defendant code takes precedence, and box 1 or 2 should be marked.

Diversity of citizenship. (4) This refers to suits under 28 U.S.C. 1332, where parties are citizens of different states. When Box 4 is checked, the citizenship of the different parties must be checked. (See Section III below; federal question actions take precedence over diversity cases.)

III. Residence (citizenship) of Principal Parties. This section of the JS 44 is to be completed if diversity of citizenship was indicated above. Mark this section for each principal party.

IV. Nature of Suit. Place an "X" in the appropriate box. If the nature of suit cannot be determined, be sure the cause of action, in Section VI below, is sufficient to enable the deputy clerk or the statistical clerks in the Administrative Office to determine the nature of suit. If the cause fits more than one nature of suit, select the most definitive.

V. Origin. Place an "X" in one of the seven boxes.

Original Proceedings. (1) Cases which originate in the United States district courts.

Removed from State Court. (2) Proceedings initiated in state courts may be removed to the district courts under Title 28 U.S.C., Section 1441. When the petition for removal is granted, check this box.

Remanded from Appellate Court. (3) Check this box for cases remanded to the district court for further action. Use the date of remand as the filing date.

Reinstated or Reopened. (4) Check this box for cases reinstated or reopened in the district court. Use the reopening date as the filing date.

Transferred from Another District. (5) For cases transferred under Title 28 U.S.C. Section 1404(a). Do not use this for within district transfers or multidistrict litigation transfers.

Multidistrict Litigation. (6) Check this box when a multidistrict case is transferred into the district under authority of Title 28 U.S.C. Section 1407. When this box is checked, do not check (5) above.

Appeal to District Judge from Magistrate Judgment. (7) Check this box for an appeal from a magistrate judge's decision.

VI. Cause of Action. Report the civil statute directly related to the cause of action and give a brief description of the cause. **Do not cite jurisdictional statutes unless diversity.** Example: U.S. Civil Statute: 47 USC 553
Brief Description: Unauthorized reception of cable service

VII. Requested in Complaint. Class Action. Place an "X" in this box if you are filing a class action under Rule 23, F.R.Cv.P.

Demand. In this space enter the dollar amount (in thousands of dollars) being demanded or indicate other demand such as a preliminary injunction.

Jury Demand. Check the appropriate box to indicate whether or not a jury is being demanded.

VIII. Related Cases. This section of the JS 44 is used to reference related pending cases if any. If there are related pending cases, insert the docket numbers and the corresponding judge names for such cases.

Date and Attorney Signature. Date and sign the civil cover sheet.